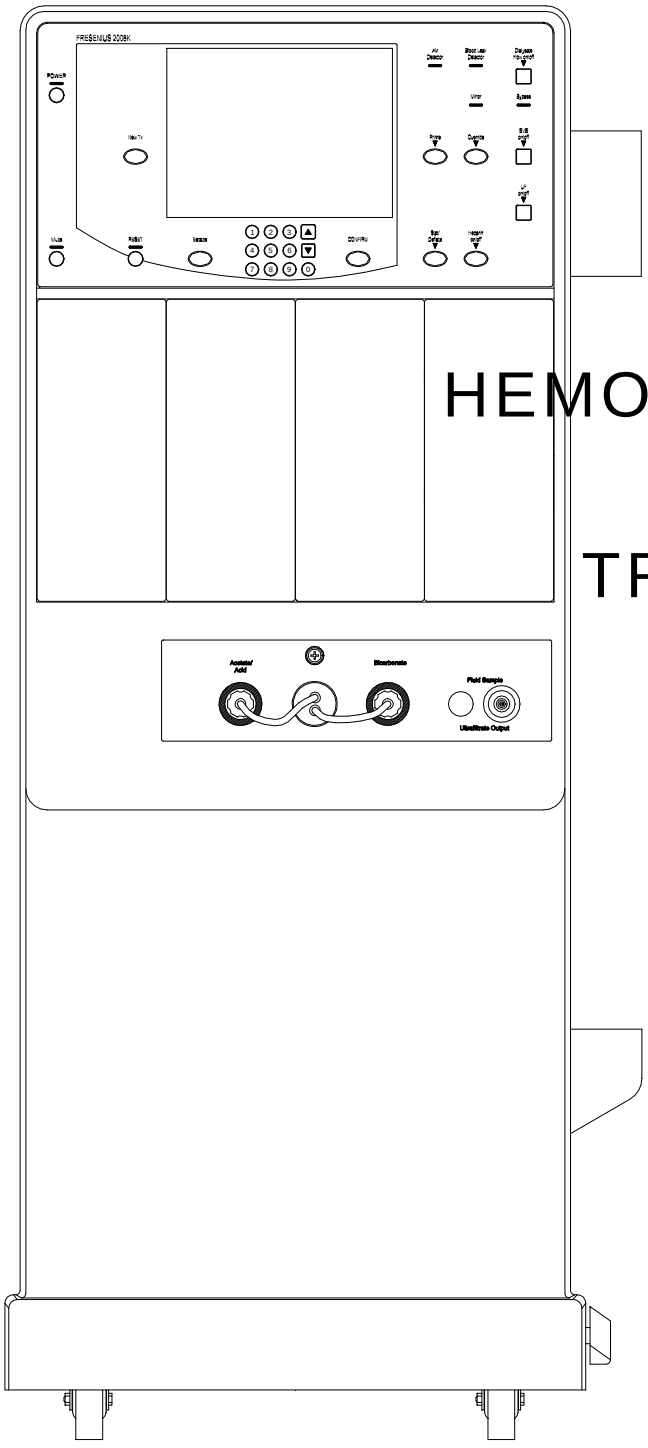

FRESENIUS 2008K HEMODIALYSIS SYSTEM

TROUBLESHOOTING GUIDE

Part Number 507298 Rev. C

FRESENIUS MEDICAL CARE NORTH AMERICA

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800-227-2572 or 925-295-0200

REGIONAL EQUIPMENT SPECIALIST: _____

FRESENIUS 2008K HEMODIALYSIS SYSTEM

TROUBLESHOOTING GUIDE

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PREFACE

This troubleshooting guide has been developed with the help of many customers and Fresenius personnel. It is a combination of known techniques and excellent feedback from people that actually work with the equipment.

The intent of the 2008K Troubleshooting Guide is to provide you with an aid in the diagnosis of common problems. Since this document is only a guide and may not provide the most up-to-date solutions for every conceivable problem, we recommend contacting our Technical Services Support line should additional assistance be required.

WARNING: Before using this guide you must read pages 1 through 4 which outline using the Troubleshooting Guide, Order of Troubleshooting, Initial Checks, Safety Checks and Equipment Needed. Never troubleshoot with a patient connected to the machine. If possible, remove the machine from the treatment area when it is being serviced. Always tag the machine to ensure it is not accidentally returned to service before the service work is completed.

Always fully test a machine (in accordance to the Technicians Manual P/N 490049 or Operators Manual P/N 490042) when maintenance and/or repairs have been completed. This is to include confirmation of conductivity, pH and Temperature with a calibrated device.

Should additional technical assistance be needed, technical support is provided 24 hours a day, seven days a week at our toll free number (800) 227-2572.

USING THE TROUBLESHOOTING GUIDE

1. We assume that the troubleshooter is qualified and has been trained to work on Fresenius machines. Incorrect troubleshooting can result in injury or death!

2. We assume that the troubleshooter has the necessary test equipment and knows how to use it.

3. Troubleshooting procedures are written in 'flow chart' style that systematically narrows in on and locates the problem. Each procedure is critical so take the time to read each one thoroughly and then proceed EXACTLY as directed. Trying to hurry, skipping steps, or second guessing will lead to error. Don't assume anything! Pay particular attention to **CAUTIONS** and **NOTES**.

4. Most hydraulic components (valves, pumps, etc) can be checked at the DISTRIBUTION BOARD. Each component has a numerically labeled connector 'position'. Referring to the HYDRAULIC FLOW DIAGRAM flow pump #21 plugs into position [P21, FLOW-P], valve 43 plugs into position [V43], etc.

NOTE: Except for the heater (**CAUTION!** High Voltage), sensor cable, actuator cable, acid pump, bicarbonate pump or blood leak detector it is okay to unplug connectors with the power on.

CAUTION! Unplugging the sensor cable, actuator cable, acid pump, bicarbonate pump and the blood leak detector with the power on may cause damage. Disconnecting the heater with the power on may cause electrocution!

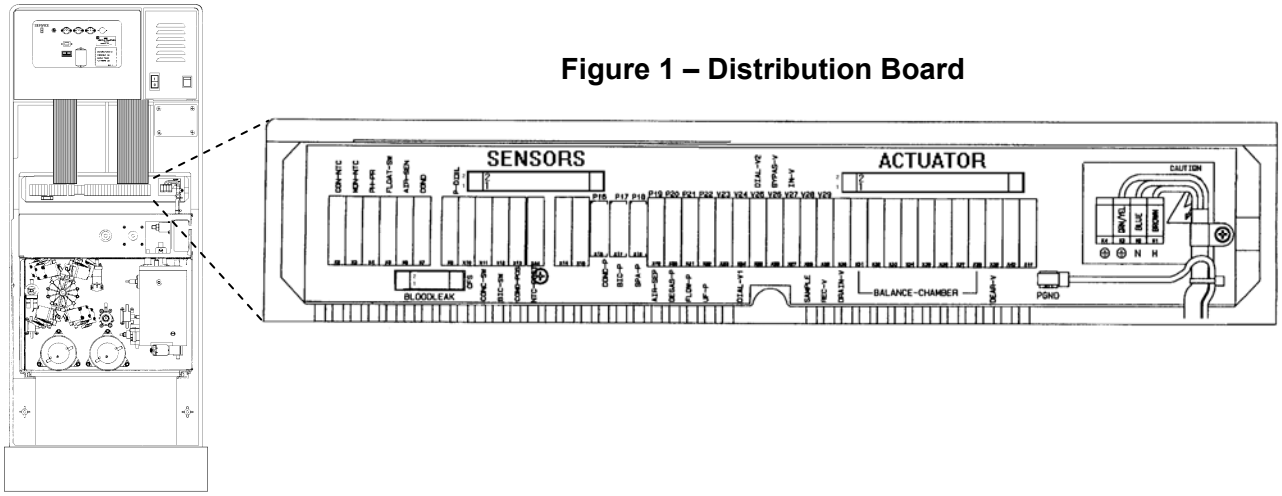


Figure 1 – Distribution Board

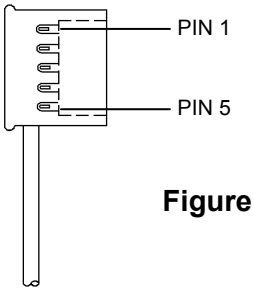


Figure 2 – Female Connector

5. If unsuccessful please call Technical Services at 1-800- 227- 2572.

THE 'ORDER' OF TROUBLESHOOTING

Troubleshoot in the following order:

1. No Water
2. Flow Errors
3. Temperature
4. Conductivity
5. TMP
6. Blood Leak
7. Pressure Holding Test Failures

NOTE: Before beginning we recommend that you perform INITIAL CHECKS (page 3). This is especially important if someone has been working on the machine before you!

1. A NO WATER alarm turns flow off. Clear NO WATER alarms before concerning yourself with other hydraulic alarms.

2. Do not concern yourself with FLOW ERRORS if a NO WATER alarm is also present. Troubleshoot a NO WATER alarm first and the FLOW ERROR will probably clear itself.

3. Do not concern yourself with a TEMPERATURE problem if a FLOW ERROR is also present. Flow errors turn the heater off. Troubleshoot the FLOW ERROR first and the TEMPERATURE problem will probably clear itself.

4. Do not concern yourself with CONDUCTIVITY problems if a TEMPERATURE problem is also present. Conductivity is temperature compensated. Troubleshoot TEMPERATURE problems first and a CONDUCTIVITY problem will probably clear itself.

5. Do not concern yourself with a TMP problem if other hydraulic alarms (i.e. conductivity, temperature, flow) are also present. Troubleshoot other hydraulic problems first and the TMP problem will probably clear.

6. Do not concern yourself with a BLOOD LEAK problem if other hydraulic alarms (i.e. conductivity, temperature, flow) are also present. Troubleshoot other hydraulic problems first and the BLOOD LEAK problem will probably clear.

CAUTION! Before placing the machine back into service always perform FINAL CHECKS (page 4).

INITIAL CHECKS

1. If the electronic card cage has been previously moved from the cabinet:
   - Check that all five boards are pushed down into the motherboard and locked in place.
   - Check that the power logic board cable is plugged in.
   - Check that the power cable is plugged into the power connector (see Figure 3 below).
2. Check that the sensor and actuator cables (see Figure 3 below) are plugged into the distribution board.
3. Check that the PGND (power ground) wire is plugged into the distribution board (see Figure 4 below). A loose PGND causes unpredictable symptoms.
4. Check cables for worn insulation (bare wires) or other signs of damage (like screw holes). Replace if damaged.
5. **NEVER** troubleshoot with the card cage open!

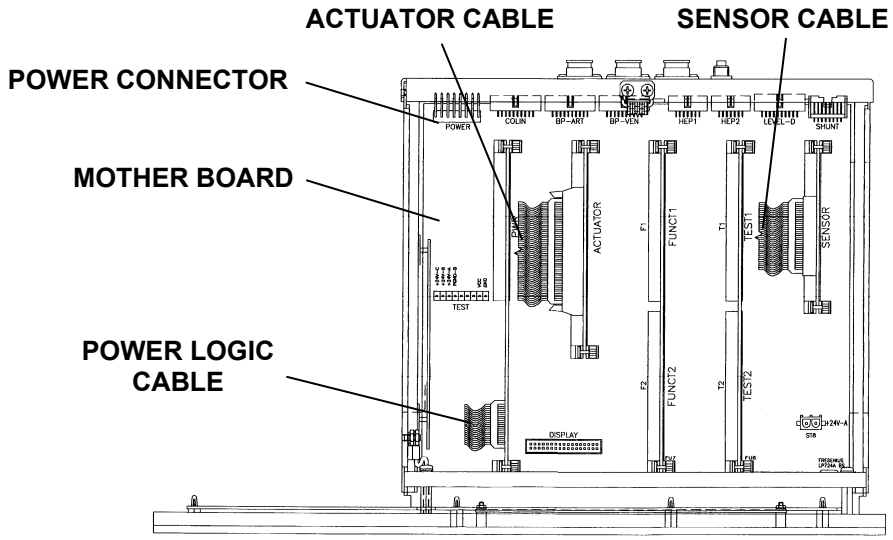


Figure 3 – Card Cage (Top View)

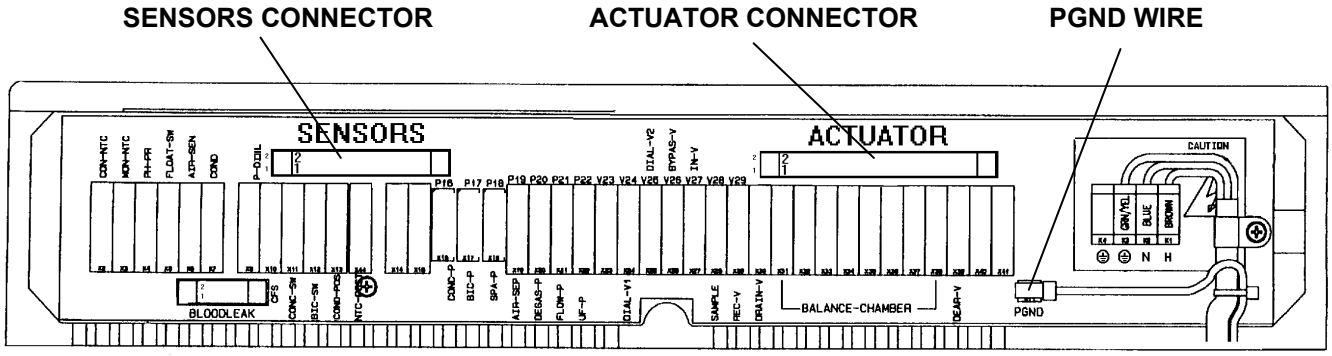


Figure 4 – Distribution Board

FINAL CHECKS

Before placing the machine back into service:

1. Remove all troubleshooting equipment (jumpers, 'dummy' connectors, etc) from the distribution board and make sure that all hydraulic components are plugged in properly.

2. If you were troubleshooting FILLING PROGRAMS or FLOW ERRORS make sure that the female connectors on chamber #69 are plugged in properly (brown wire on top).

3. Turn the heater breaker switch off. Allow eight minutes and assure that the Temperature display falls to less than 30° and that the machine goes into bypass (valve #24 closes, no flow through the external indicator).

4. Drop the acid and bicarbonate lines into water. Allow eight minutes and assure that the Conductivity display falls to 10.0 mS/cm and that the machine goes into bypass (no flow through the external indicator).

5. Check that AUDIO ALARMS are working properly.

6. **IMPORTANT!** Perform alarm and pressure holding tests. Do NOT place the machine back into service until all tests have pass.

EQUIPMENT NEEDED

- Fresenius gauge kit (part # 150034)

- Fresenius test (temperature) 'dummy connectors' (part # 190060)

- 60 ml syringe

- Flashlight

- Jumper wire

- Independently calibrated temperature, conductivity, and pressure meters

- Voltmeter

- Fluke TP80 meter probes. These probes have a slip-on cap that fits over the lead to 'isolate' the measuring point and assures safe voltage measurements in ‘tight’ areas when shorting other pins or connectors is a concern.

Figure 5 - Fluke TP80 Meter Probes (with slip on cap)

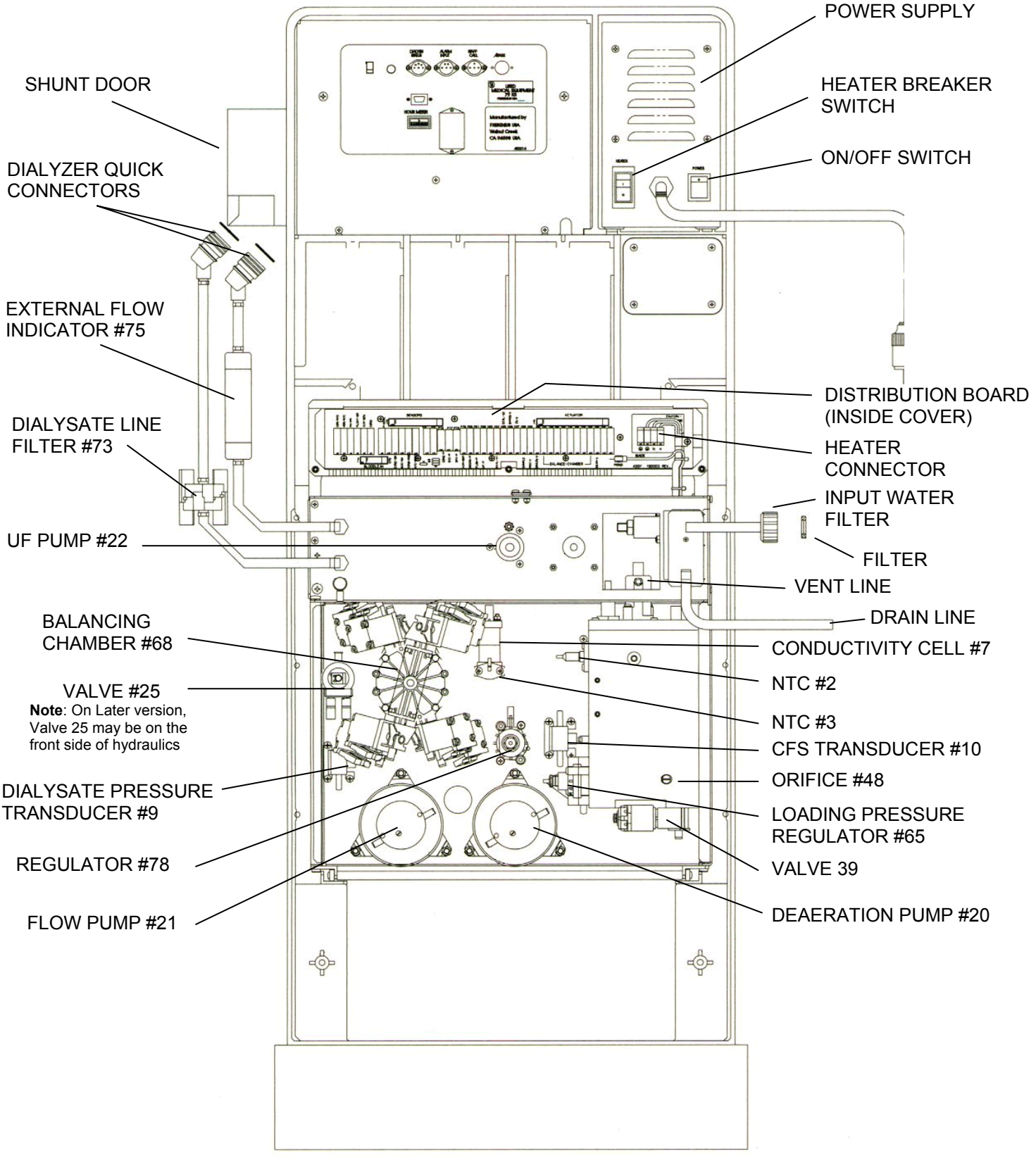


Figure 6 – Machine Rear View

SECTION 1 - FLOW ERRORS IN DIALYZE MODE

F- 1.0.0 CHECK LOADING PRESSURE

a) Assure that the vent tubing (back of machine) is not 'pinched' (see Figure 6, page 5).

b) Assure that dialysate flow is on (flow on/off LED off).

c) [1]**TIGHTLY** insert a [2]loading pressure gauge into the red ACETATE/ACID port. Proceed accordingly:

- 0 to 10 psi. — See F- 15.0.0, LOW LOADING PRESSURE (page 19).
- 10 to 17 psi. — Calibrate loading pressure per CALIBRATION PROCEDURES. If unsuccessful, the loading pressure regulator #65 (see Figure 6, page 5) may be bad.
- 18 to 25 psi. — See F- 2.0.0
- Greater than 25 psi — Calibrate loading pressure per CALIBRATION PROCEDURES. If unsuccessful the loading pressure regulator #65 (see Figure 6, page 5) may be bad.

[1] If the gauge is not in the port correctly you will always read low pressure!

[2] If the gauge does not read 0 psi at atmosphere compensate for this when reading it.

F- 2.0.0 CHECK DEBUG ERRORS (NO WATER AND FLOW ERROR)

a) Lift the shunt door to force bypass (bypass LED on). This should be done even if the machine is already in bypass!

NOTE Unless instructed do NOT try to reset alarms while troubleshooting flow errors.

b) Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch for two minutes or until you see either a NO WATER alarm or a flow error (FLOW ERROR = "1"). Proceed accordingly:

- NO WATER alarm (intermittent or constant). See SECTION 2 - NO WATER (page 24).
- FLOW ERROR = "0" (constant). See F- 2.0.1
- FLOW ERROR = "1" (intermittent or constant). See F- 3.0.0

F- 2.0.1 FLOW ERROR NOT INDICATED (FLOW ERROR = "0")

a) Leaving the shunt door open push the blue HOME screen button to return to the Home screen. Allow Temperature and Conductivity to come out of alarm state.

NOTE: If the Temperature or Conductivity windows (in the main screen) are RED an alarm is present. When alarms clear the windows turn yellow.

NOTE: Conductivity alarm limits can be adjusted: 1) Push the Conductivity data button to go to the Dialysate screen. Select either Alarm Position or Alarm Width by pushing the appropriate blue screen button 2) Adjust the limits using the UP or DOWN arrow keys. 3) Push the CONFIRM key. 4) Push the blue HOME screen button to return to the Home screen.

NOTE: If Temperature and Conductivity alarms do not clear and you are sure that FLOW ERROR = "0" constant do NOT continue troubleshooting flow errors!

b) Close the shunt door. Assure that the machine is 'out of bypass' (bypass LED turns off). Is there flow through the external flow indicator (is the bob rising)?

Yes See F- 2.0.2

No See F- 14.0.0, TROUBLESHOOTING FLOW ERRORS 'OUT OF BYPASS' (page 18).

F- 2.0.2 CHECK FLOW ERROR 'OUT OF BYPASS'

Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch FLOW ERROR for five minutes or until you see FLOW ERROR = "1". Proceed accordingly:

- FLOW ERROR = "0" (constant). Stop here! A flow error is not present.
- FLOW ERROR = "1" (intermittent or constant). See F- 14.0.0, TROUBLESHOOTING FLOW ERRORS 'OUT OF BYPASS' (page 18).

F- 3.0.0 CHECK FOR FILLING PROGRAM

Call debug screen 1. FILACT = "1"?

Yes Proceed to SECTION 8 - FILLING PROGRAM PROBLEMS (page 64)

No See F- 4.0.0

F- 4.0.0 CHECK FOR A VALVE ERROR (VERR)

NOTE: Valve errors are caused by electrical current problems in a 'valve circuit'. If present, VERR (debug screen 1) increases (to a maximum of 255). If not present VERR remains 0.

Call debug screen 1. VERR is in the lower right corner. Is VERR = "0"?

Yes See F- 4.0.1

No **NOTE** that you are in DIALYSIS program and proceed to TROUBLESHOOTING VALVE ERRORS (page 31)

F- 4.0.1 CHECK FLOW ERROR "IN BYPASS"

Open the shunt door to cause bypass. Go to debug screen 0 and watch Flow Error for one minute. Does Flow Error remain "0" constantly or does it still = "1" (either constant or intermittent)?

"0" constant See F- 2.0.2

Still = "1" Close the shunt door and see F- 5.0.0

F- 5.0.0 CHECK FOR A RUNNING FLOW MOTOR

The flow pump's motor shaft can be viewed from the front of the hydraulics (see Figure 7). Is the shaft rotating counter-clockwise (viewed from the FRONT!)?

Yes See F- 6.0.0

No See TROUBLESHOOTING MOTORS (page 23) to check the **FLOW MOTOR**.

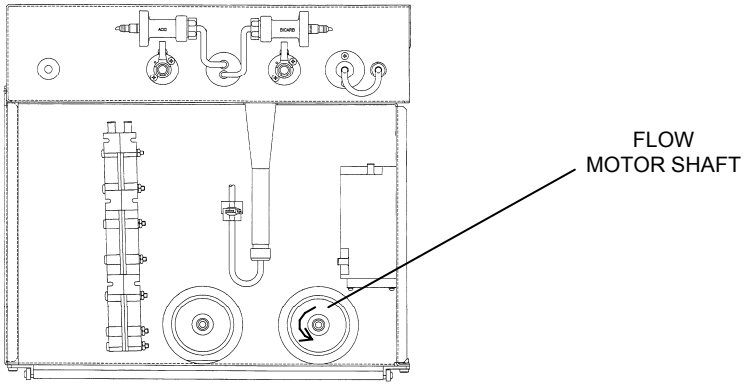


Figure 7 – Hydraulics (Front View)

F- 6.0.0 CHECK FLOW PUMP CONTROL

Turn dialysate flow off (flow on/off LED on) and check the flow pump's motor shaft again. Still rotating?

Yes Replace the actuator board (shorted driver).

No See F- 7.0.0

F- 7.0.0 DETERMINE DRAIN FLOW

Normal Fresenius flow 'pulses' in 30 ml (approximately) increments when the balancing chamber valves cycle and 'stops completely' in between. Determine flow 'type' as defined below:

- Normal: 30 ml - Stops completely - 30 ml - Stops completely – etc
- Abnormal: Continuous flow (never stops, i.e. cannot distinguish 30 ml increments)

  OR

  30 ml – continuous – 30 ml – stops completely - etc
- None: No drain output

a) IMPORTANT: Turn dialysate flow on (flow on/off LED off).

b) Go to end of the drain tubing. Hold the tubing so that the opening is pointed **UPWARD!** (at about 45 degrees). **CAUTION!!** If the opening is held DOWNWARD this test is invalid.

c) Watch drain flow for 30 seconds. Proceed accordingly:

- Normal: See F- 8.0.0 (page 12)
- Abnormal or None: See F- 7.0.1

F- 7.0.1 CHECK (DRAIN) VALVE #30 INPUT

a) Turn dialysate flow off (flow on/off LED on) and remove (drain) valve 30's INPUT tubing (see Figure 8). Point the tubing's output AWAY from the hydraulics! Have a bucket ready to catch any output.

b) Turn dialysate flow on (flow on/off LED off). Proceed accordingly:

- Normal: See F- 7.0.2
- Abnormal or None: See F- 7.0.3

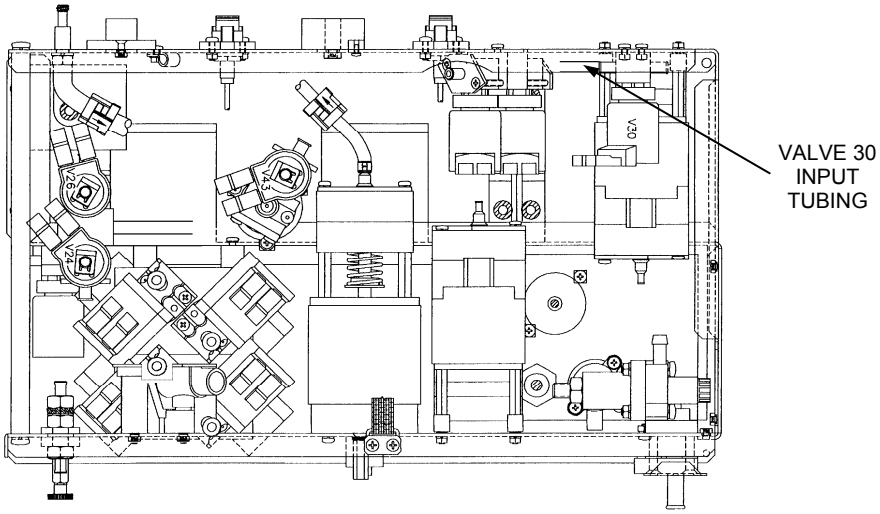


Figure 8 – Hydraulics (Top View)

F- 7.0.2 CHECK VALVE #30 OUTPUT

a) Turn flow off (flow on/off LED on) and reconnect the tubing to valve 30.

b) Remove the tubing from bottom (drain) port at the rear of the machine (see Figure 9). Have a bucket ready to catch any output.

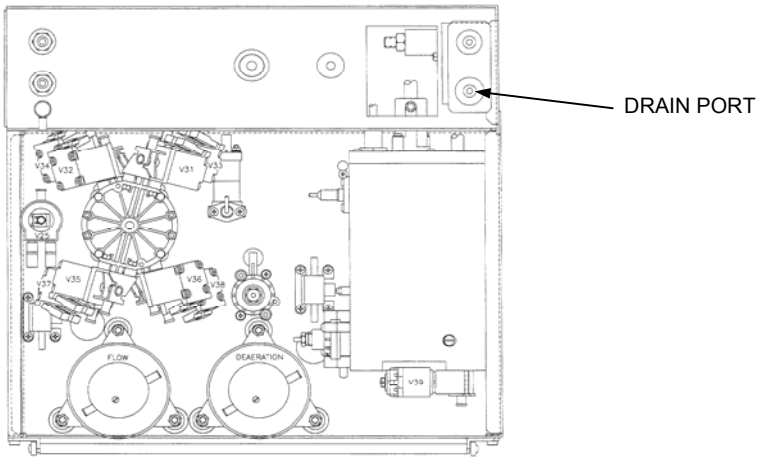


Figure 9 - Hydraulics (Rear View)

c) Turn flow on (flow on/off LED off). Proceed accordingly:

- Normal: The drain tubing or the drain itself is restricted. Locate and repair.
- Abnormal or None: A problem is indicated with the actuator board or VALVE 30. **NOTE** this and proceed to TROUBLESHOOTING VALVES (page 30).

F- 7.0.3 CHECK FILLING PROGRAM FUNCTION

a) Unplug the air sensor connector from distribution board position x6, AIR-SEN.

b) Wait 30 seconds and call debug screen 1. Does FILACT = "1"?

Yes A) Plug the connector back into the distribution board (position x6, AIR_SEN), allow 30 seconds, and assure that FILACT = "0"; B) See F– 7.0.4

No Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage). If no corrosion, two possibilities: 1) Bad sensor board; 2) Bad function board.

F- 7.0.4 CHECK 'IN BYPASS' FLOW

For this procedure a bucket 1/2 filled with water is needed.

a) Plug the acid and bicarbonate concentrate connectors into their ports. The screen returns to the SELECT PROGRAM screen.

b) Reconnect the tubing to valve 30.

c) Place the machine into RINSE.

d) Open the shunt door (COVER OPEN message) and remove both quick connectors. Drop the RED quick connector into the bucket. Hold the BLUE quick connector over the bucket such that the opening is held **UPWARD!** (at about 45 degrees). **CAUTION!!** If the opening is held DOWNWARD this test is invalid.

e) IMPORTANT leave the shunt door open!

f) Watch flow here for 30 seconds and **NOTE** flow 'type' (Normal, Abnormal, None) for later use. Proceed to step F- 7.0.5

F- 7.0.5 DETERMINING DIASAFE® FILTER

The DIASAFE® filter looks like a dialyzer that is mounted in the bottom compartment under the hydraulics. Also, there is a 'test valve' on the rear panel.

a) Unplug the acid connector from its port to INTERRUPT rinse then plug it back in.

b) Place the quick connectors back into the shunt and close the door.

c) Does this machine have a DIASAFE® filter?

Yes See F- 7.0.6

No See F- 7.0.8

F- 7.0.6 CHECK THE DIASAFE® FILTER

a) If the DIASAFE® filter and its quick connector o-rings have not been replaced in the last 90 days do so now and see F- 7.0.7. If it has been replaced see part b.

b) Assure that the 'test valve' is set in DIALYZE position. If not, set it there, and see F– 7.0.7. If already in DIALYZE position see part c

c) Check for tubing restrictions at the DIASAFE® filter. Clear all restrictions and see F- 7.0.7. If not restricted see step F- 7.0.8

F- 7.0.7 TROUBLESHOOTING THE DIASAFE® FILTER

a) Return to the SELECT PROGRAM screen by reconnecting the acid and bicarbonate concentrate connectors to their ports on the front of the machine.

b) Place the machine into RINSE for three minutes.

c) Remove the acid and bicarbonate concentrate connectors from their ports and plug them back into concentrate.

d) If the DIASAFE® filter was the problem the flow error will clear. Return to step F- 2.0.0.

F- 7.0.8 DETERMINE FLOW PROBLEM

As noted, in step F- 7.0.4 above, was flow through the BLUE quick connector:

- Normal: A problem is indicated with the actuator board or VALVE 26. **NOTE** this and proceed to TROUBLESHOOTING VALVES (page 30).
- Abnormal: See F- 7.0.9
- None: Possibly two balancing chamber valves stuck closed! Try replacing the actuator board.

F- 7.0.9 CHECK BALANCING CHAMBER VALVES AND BALANCING CHAMBER DIAPHRAGM

Perform SECTION 18 - MANUAL BALANCING CHAMBER VALVE LEAK TESTS (page 92) on the balancing chamber valves (V31 through V38). Did the leak test indicate a leaking valve?

Yes See F- 7.1.1

No Possible leaking balancing chamber diaphragm. Perform SECTION 19 - TESTING FOR A LEAKING BALANCING CHAMBER DIAPHRAGM (page 96).

F- 7.1.1 CHECK FOR A SHORTED VALVE DRIVER

a) Unplug the indicated leaking valve from the distribution board (see Figure 10 below). Using a flashlight, check inside the distribution board, for 'white corrosion' (indicative of spillage).

b) If no corrosion: measure volts dc, inside the distribution board, BETWEEN **male** pins 1 and 5 (top and bottom). Place the red lead at pin 5 (bottom). Greater than one volt?

Yes Replace the actuator board (shorted driver).

No Replace the indicated leaking balancing chamber valve.

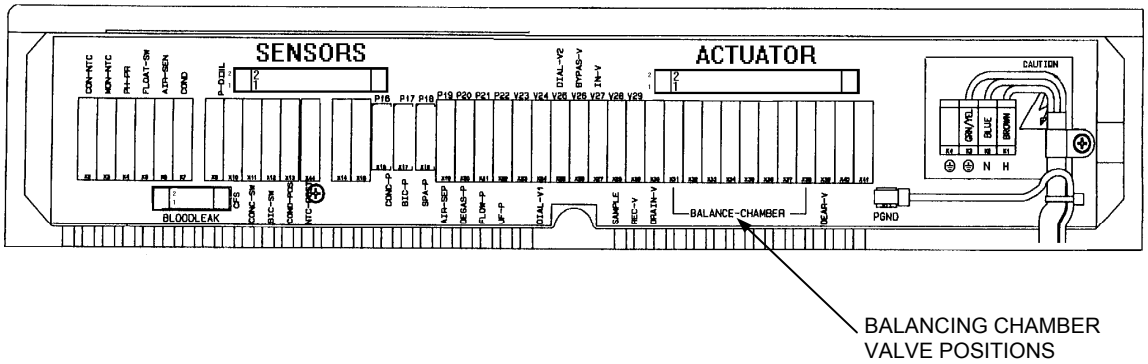


Figure 10 – Distribution Board

F- 8.0.0 CHECK CFS TRANSDUCER SIGNAL (ACFS)

Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch ACFS (in volts) for two minutes or until you have determined the symptom. Proceed accordingly:

- ACFS remaining between 3.0 and 7.0. See F- 9.0.0 (page 13)
- ACFS remaining between 7.0 and 12. See F- 10.0.0 (page 14*)
- ACFS remaining between 0 and 3.0. See F- 11.0.0 (page 14)
- ACFS cycling from about 4 (4.0 to 5.5) to about 2 (0 to 3.0). See F- 13.0.0 (page 17).
- ACFS intermittently going to between 7 and 12. See F- 10.0.0 (page 14)

F- 9.0.0 ACFS BETWEEN 3.0 AND 7.0 - CHECK FLOW PUMP PRESSURE

The CFS signal is not switching the balancing chambers properly.

a) Turn dialysate flow off and tee a psi gauge between the flow pump's output nozzle and the WHITE tubing (see Figure 11 below, for gauge location).

b) Turn the dialysate flow on (flow on/off LED off) and set to 500 ml/min. Does pressure peak to 14 psi or greater?

Yes See F- 9.0.2

No See F- 9.0.1

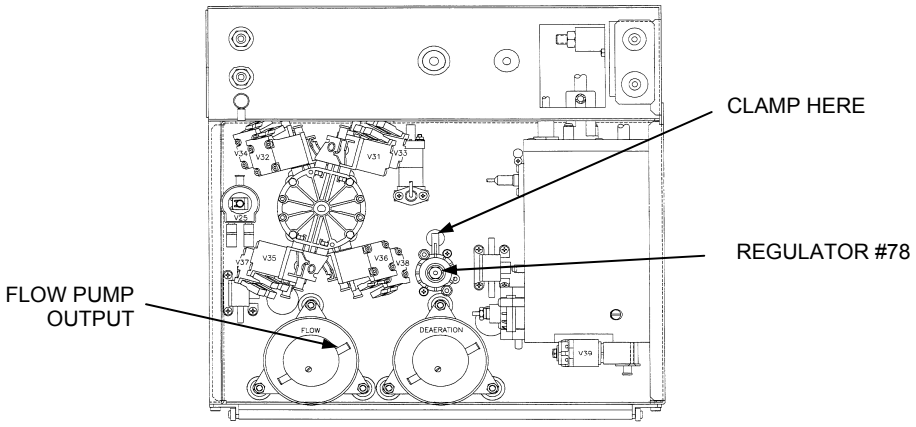


Figure 11 - Hydraulics (Rear View)

F- 9.0.1 CHECK FLOW RELIEF PRESSURE REGULATOR #78

With a metal hemostat TIGHTLY clamp regulator #78 at the location specified in the Figure 11 above. Does flow pump pressure peak to 14 psi or greater now?

Yes Calibrate FLOW RELIEF PRESSURE per CALIBRATION PROCEDURES. If unsuccessful regulator #78 may be malfunctioning.

No Three possibilities: 1) Bad actuator board; 2) Bad flow pump head; 3) Bad flow pump motor

F- 9.0.2 CHECK CFS CIRCUIT

a) Unplug the CFS transducer from distribution board position CFS. Using a flashlight, check inside the distribution board, for 'white' corrosion (indicative of spillage).

b) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

c) If all pins are okay: is ACFS between 7.0 and 10?

Yes See F- 9.0.3

No See F- 12.0.0 (page 16)

F- 9.0.3 CHECK SENSOR BOARD CABLE

a) Plug the CFS transducer back into the distribution board.

- If ACFS remains between 7 and 10 make sure that you have plugged in properly.
- If ACFS starts cycling from about 4 (4.0 to 5.5) to about 2 (0 to 3.0) and if the flow error is still present return to F- 2.0.0

b) Have you tried calibrating FLOW RELIEF PRESSURE during this troubleshooting session?

Yes Three possibilities: 1) Bad CFS transducer (see Figure 6, page 5); 2) Bad flow pump head; 3) Bad flow motor (try new brushes)

No Try calibration FLOW RELIEF PRESSURE per CALIBRATION PROCEDURES and return to F- 2.0.0. If FLOW RELIEF PRESSURE was the problem, the flow error will clear.

F- 10.0.0 ACFS BETWEEN 7.0 AND 10 – CHECK CFS CIRCUIT

The CFS transducer is acting 'open'.

a) Unplug the CFS transducer from distribution board position CFS. Using a flashlight, check inside the distribution board connector for 'white' corrosion (indicative of spillage).

b) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

c) If all pins are okay: plug the 34degree temperature 'dummy connector' into distribution board position CFS (this simulates a good transducer). From debug screen 0, does ACFS go to 0?

Yes See F- 10.0.1

No Possible: 1) [1]Bad sensor board cable; 2) Bad sensor board; 3) Bad actuator board

[1]The sensor board cable can be checked for continuity. Note that you are checking **CFS TRANSDUCER** connections and proceed to SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

F- 10.0.1 CHECK CFS TRANSDUCER

Plug the CFS transducer back into the distribution board. Does ACFS start cycling from about 4 (4.0 to 5.5) to about 2 (0 to 3.0)?

Yes The CFS transducer seems to be working okay. Return to F- 2.0.0 but if you return here replace the CFS transducer (see Figure 6, page 5)

No Bad CFS transducer (see Figure 6, page 5).

F- 11.0.0 ACFS BETWEEN 0 AND 3.0 – CHECK FLOW PUMP 'DEAD HEAD'

The CFS transducer is acting 'shorted'.

Turn dialysate flow off (flow on/off LED on). Is ACFS between 4.0 and 7.0?

Yes The CFS transducer is good! Return to F- 2.0.0.

No See F- 11.0.1

F- 11.0.1 CHECK CFS CIRCUIT

a) Unplug the CFS transducer from distribution board position CFS. Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage).

b) If corrosion not present: Inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

c) If all five pins are okay: is ACFS between 7.0 and 10?

Yes See F- 11.0.3

No See F- 12.0.0

F- 11.0.3 CHECK FOR A LEAKING BALANCING CHAMBER VALVE

a) Plug the CFS transducer back into the distribution board. If ACFS remains between 7 and 12 make sure that you have plugged the transducer in properly.

b) Turn dialysate flow on (flow on/off LED off).

c) Push the blue HOME screen button to return to the main dialysis screen. Does the digital TMP reading have positive (+) sign (example +220 mmHg)?

Yes See F- 11.0.4

No Replace the CFS transducer (see Figure 6, page 5).

NOTE: TMP readings with no sign (example 220 mmHg) indicates that venous pressure is greater than dialysate pressure. If TMP readings have a positive sign (example +220 mmHg) dialysate pressure is greater than venous pressure.

F- 11.0.4 CHECK FOR (+) POSITIVE TMP

a) Push and release the RESET key. The message "RESET TO ADJUST TMP" appears.

b) Immediately push and HOLD the RESET key. After the "ADJUSTING TMP" message is gone does TMP return to a positive (+) value or remain relatively stable?

Returns positive (+) See F- 11.0.5

Remains stable Replace the CFS transducer (see Figure 6, page 5).

F- 11.0.5 CHECKING BALANCING CHAMBER VALVES

Perform SECTION 18 - MANUAL BALANCING CHAMBER VALVE LEAK TESTS (page 92) on the balancing chamber valves (V31 through V38). Did the leak test indicate a leaking valve?

Yes See F- 11.0.6.

No Replace the CFS transducer (see Figure 6, page 5).

F- 11.0.6 CHECK FOR A SHORTED VALVE DRIVER

Remain in DIAGNOSTICS for this procedure.

a) Unplug the NOTED leaking balancing chamber valve from the distribution board. Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage).

b) Measure volts dc, inside the distribution board, BETWEEN **male** pins 1 (top) and 5 (bottom). Place the meter's red lead at pin 5. Greater than one volt?

Yes Replace the actuator board (shorted driver).

No Replace the NOTED leaking balancing chamber valve

F- 12.0.0 CHECK SENSOR BOARD CABLE

a) Turn the power off, slide the electronic card cage out, and unplug the sensor board's ribbon cable (see Figure 3, page 3).

b) Check, inside the sensor board connector, for bent or broken **male** pins.

c) If pins are okay: leaving the cable unplugged, turn the power on.

d) Return to debug screen 0. Ignore all alarms! Is ACFS between 7.0 and 10?

Yes A) Unplug the sensor board ribbon cable from the distribution board SENSORS connector (see Figure 12 below); B) Using a flashlight, check inside the distribution board's SENSORS connector for 'white' corrosion (indicative of spillage) and for bent or broken **male** pins; C) If no corrosion and all pins are okay: replace the sensor board ribbon cable.

No Possible: 1) Bad sensor board; 2) Bad actuator board.

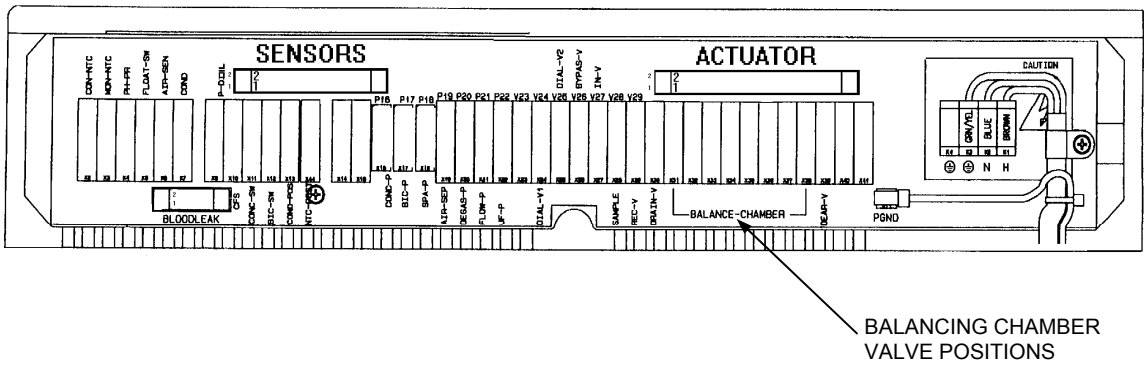


Figure 12 – Distribution Board

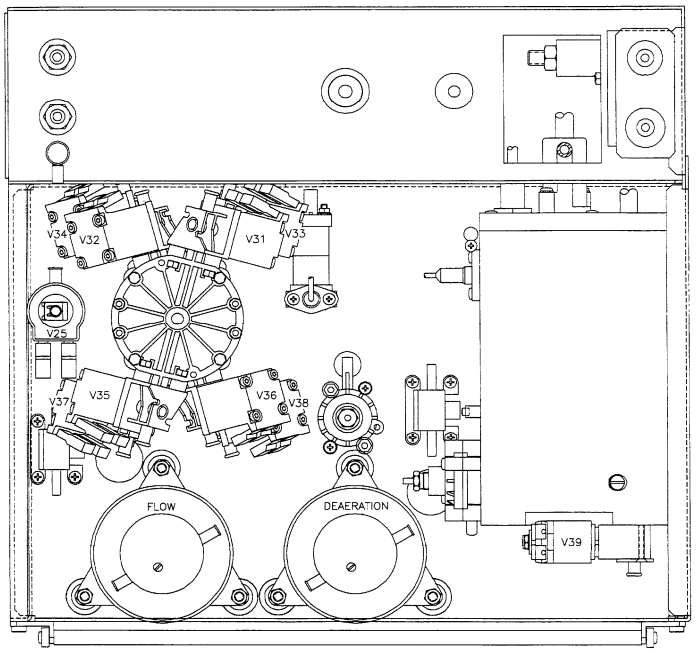


Figure 13 - Hydraulics (Rear View)

F- 13.0.0 ACFS CYCLING - CHECK BALANCING CHAMBER VALVES (STUCK CLOSED)

a) Assure that all balancing chamber valves are plugged into the distribution board at their proper position (see Figure 12, page 16 and Figure 13 above).

b) IMPORTANT: Set dialysate flow rate to 500 ml/min.

NOTE: Flow errors caused by a balancing chamber valve not opening are predictably cyclic.

c) Call debug screen 0 and watch ACFS for one minute. Is ACFS cycling from about 4 volts (4.0 to 5.5 volts) where it remains for 3 seconds to about 2 volts (0 to 2.8 volts) where it remains for ten seconds?

Yes A balancing chamber valve is not opening. See F- 13.0.1

No Return to step F- 2.0.0

F- 13.0.1 CHECK THE ACTUATOR BOARD

Have you already tried replacing the actuator board during this troubleshooting session?

Yes See F- 13.0.2

No Try replacing the actuator board and return to F- 2.0.0. If the actuator board is the problem the flow error will clear.

F- 13.0.2 TROUBLESHOOTING A 'MECHANICALLY' CLOSED BALANCING CHAMBER VALVE

a) Using a metal hemostat tightly clamp balancing chamber valve #35 as close to the valve as you can. From the rear valve #35 is in the lower, left side (see Figure 13, page 17).

b) Wait 30 seconds. From debug screen 0 does ACFS remain between 0 and 2.8 and FLOW ERROR = "1" constant?

Yes Valve #33 or #34 or #37 or #38 is not opening.

No Flow Error remains intermittent: Valve #31 or #32 or #35 or #36 is not opening.

F- 14.0.0 TROUBLESHOOTING FLOW ERRORS 'OUT OF BYPASS'

A restriction is indicated in the 'out of bypass' circuit, which includes the *DIASAFE® filter (if present), external dialysate filter #73, valve #24 and valve #25.

*The DIASAFE® filter looks like a dialyzer that is mounted in the bottom compartment under the hydraulics. Also, there is a 'test valve' on the rear panel

Normal Fresenius flow pulses in 30 ml (±1ml) increments when the balancing chamber valves cycle and 'stops completely' in between. During the following procedure determine flow 'type' as defined below:

- Normal: 30 ml - Stops completely - 30 ml - Stops completely – etc
- Abnormal: Continuous flow (never stops, i.e. cannot distinguish 30 ml increments)
- None: No output

F- 14.0.1 CHECK V24 AND THE DIASAFE® FILTER (IF PRESENT)

a) Plug the acid and bicarbonate concentrate connectors into their ports. The machine returns to the SELECT PROGRAM screen.

b) Place the machine into RINSE. Have a bucket ready to catch any output.

c) With a bucket ready to catch any output, open the shunt door (COVER OPEN message) and remove the RED quick connector.

d) IMPORTANT Leave the door open! There should be flow through the shunt door port. Proceed accordingly:

- Normal: See F- 14.0.2 (valve #24 and the DIASAFE® filter (if present) are okay)
- Abnormal or None: See F- 14.0.3

F- 14.0.2 CHECK EXTERNAL DIALYSATE FILTER #73

a) Unplug the acid connector from its port to INTERRUPT rinse then plug it back in.

b) Place the quick connectors back into the shunt and close the door.

c) Check the external dialysate filter #73 (see Figure 6, page 5) for restrictions.

d) If filter #73 is okay: a problem is indicated with the actuator board or VALVE 25. **NOTE** this and proceed to TROUBLESHOOTING VALVES (page 30).

F- 14.0.3 CHECK V24 AND THE DIASAFE® FILTER

a) Unplug the acid connector from its port to INTERRUPT rinse then plug it back in.

b) Place the quick connectors back into the shunt and close the door.

c) Does this machine have the DIASAFE® filter?

Yes See F- 14.0.4

No A problem is indicated with the actuator board, actuator cable, or VALVE 24. **NOTE** this and proceed to TROUBLESHOOTING VALVES (page 30).

F- 14.0.4 CHECK DIASAFE® FILTER

a) If the DIASAFE® filter and its quick connector o-rings have not been replaced in the last 90 days do so now and see F- 14.0.5. If it has been replaced, proceed to part b.

b) Assure that the 'test valve' is set in DIALYZE position. If not set it there and see F- 14.0.5. If already set in DIALYZE position proceed to part c.

c) Check for tubing restrictions at the DIASAFE® filter. Clear all restrictions and see F- 14.0.5. If not restricted proceed to part d.

d) A problem is indicated with the actuator board or VALVE 24. **NOTE** this and proceed to TROUBLESHOOTING VALVES (page 30).

F- 14.0.5 TROUBLESHOOTING THE DIASAFE® FILTER

a) Return to the SELECT PROGRAM screen by reconnecting the acid and bicarbonate concentrate connectors to their ports on the front of the machine.

b) Place the machine into RINSE for three minutes.

c) Remove the acid and bicarbonate concentrate connectors from their ports and plug them back into concentrate.

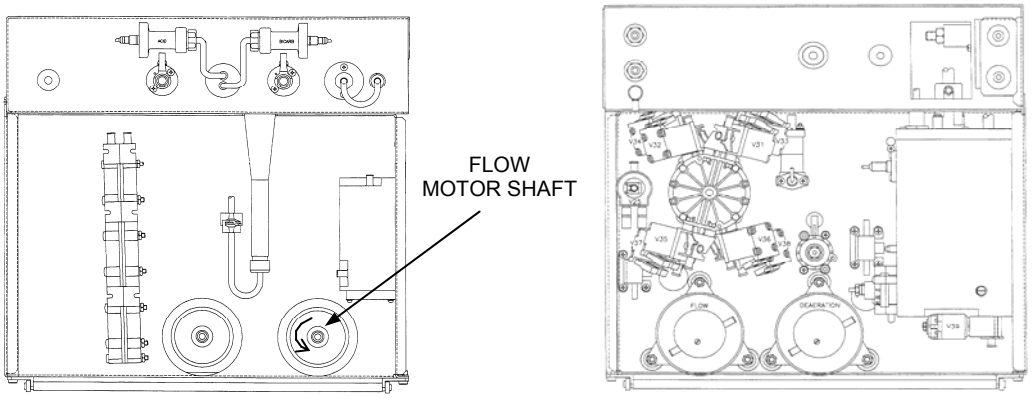
d) If the DIASAFE® filter was the problem the flow error will clear. Return to step F- 2.0.0.

F- 15.0.0 LOADING PRESSURE LOW (0 to 10 psi) /CHECK DEAERATION PUMP

The deaeration pump's motor shaft can be viewed from the front of the hydraulics (see Figure 14, page 20). Is the shaft rotating counter-clockwise (from the FRONT!)?

Yes See F- 15.0.1

No See TROUBLESHOOTING MOTORS (page 23) to check the **DEAERATION MOTOR**.



HYDRAULICS (FRONT VIEW) **HYDRAULICS (REAR VIEW)**

Figure 14

F- 15.0.1 LOADING PRESSURE LOW - DEAERATION MOTOR RUNNING

NOTE: This procedure checks for water in the hydro block.

a) Turn flow off (flow on/off LED on). Call debug screen 0 and wait until DEAP = 255 (indicates deaeration motor is off).

b) Remove the CLEAR (input) tubing from the deaeration pump's nozzle (see Figure 14 above). Hold it below the pump. Is there continuous (never stops) flow from this tubing?

Yes See F- 15.0.2

No See F- 15.0.5

F- 15.0.2 CHECK INCOMING WATER

a) Allow flow to continue from the tubing (use a bucket to catch it).

b) Call debug screen 0. When the float's bob drops, incoming water valve #41 is energized open. This is indicated when the circle (next to the valve) turns solid blue. Normally (if the incoming water circuit is okay) valve #41 will open for about one second per cycle.

c) Intermittent water problems are missed with a 'quick look'. Watch specifically (and carefully) for a NO WATER alarm for two minutes. Is a NO WATER alarm ever present?

Yes Reconnect the tubing to the deaeration pump and see SECTION 2 - NO WATER (page 24).

No See F- 15.0.3

F- 15.0.3 RECHECK LOADING PRESSURE

a) Reconnect the tubing and turn flow on (flow on/off LED off).

b) Wait 30 seconds. Does loading pressure return to normal (18 to 25 psi)?

Yes Problem maybe solved. If low loading pressure symptoms repeat: 1) Possible bad deaeration pump head; 2) Possible bad deaeration motor (try brushes); 3) Possible bad (intermittent) float switch; 4) Possible stripped orifice fitting or bad orifice o-rings.

No See F- 15.0.4

F- 15.0.4 CHECK DEAERATION PUMP AND LOADING PRESSURE REGULATOR

While watching the loading pressure gauge, tightly clamp the white tubing between the loading pressure regulator #65 and the hydroblock (see Figure 15 below). Does loading pressure increase to greater than 20 psi?

Yes The loading pressure regulator #65 (see Figure 15 below) is bad.

No Two possibilities: 1) Deaeration pump head; 2) Deaeration motor brushes (see brush replacement process in the PREVENTATIVE MAINTENANCE manual).

F- 15.0.5 CHECK THE ORIFICE AND FLOAT

a) Reconnect the tubing and turn the water OFF.

b) Clamp the hydro block vent tube (see Figure 15 below). Unscrew and pull the orifice (#48) from the hydro block (see Figure 15 below). If the small opening, at the end of the shaft, is plugged this is the problem!

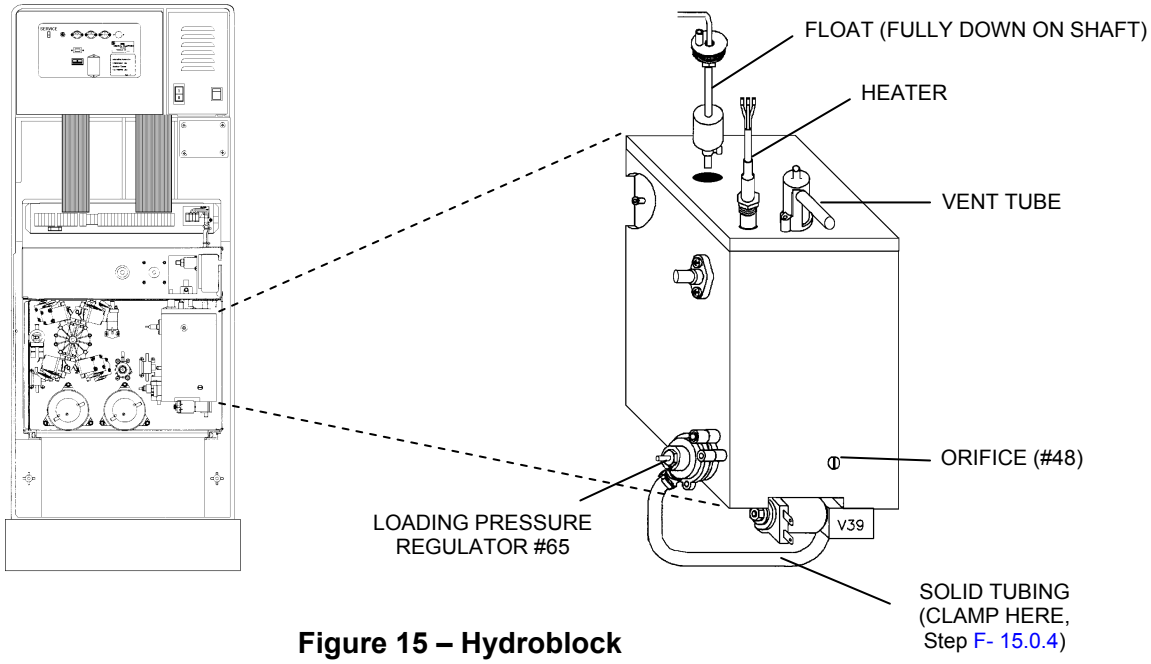


Figure 15 – Hydroblock

c) Re-install the orifice (don't over tighten!) and UNCLAMP the vent tube.

d) Remove the float (see Figure 15 above). **CAUTION!** Don't pull on the wiring harness!

e) Holding the float **FULLY UP** turn the water ON.

f) **CAUTION** Avoid overflow during this step! Looking into the hydro block's float cavity move the float bob **FULLY DOWN**. Is the water level rising?

Yes a) Turn the water off and reinstall the float; b) Turn the water on and see F- 15.0.7

No See F- 15.0.6

F- 15.0.6 CHECK THE FLOAT CIRCUIT

a) Turn the water off.

b) Unplug the float from distribution board position FLOAT-SW. Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage).

c) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

d) If all pins are okay: place a jumper wire, inside the distribution board, BETWEEN **male** pins 1 and 3 (top and middle). This simulates a 'closed' float switch. **IMPORTANT**! Make VERY sure of a good jumper connection!

e) Call debug screen 0. Is the circle next to valve #41 solid blue (indicating valve #41 is energized)?

Yes The float is bad. Replace it and see F 15.0.7

No Two possibilities: 1) *Bad sensor board cable; 2) Bad actuator board.

*The sensor cable can be checked for continuity. Note that you are checking the FLOAT connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

F- 15.0.7 CLEARING AN AIR LOCK

There should be flow through the hydro block unless an air lock is present.

a) Assure that the water in ON.

b) Connect a 60 ml syringe (with plunger) to the deaeration pumps clear INLET tubing and draw on the plunger. You may have to pull several syringes full of air before you achieve continuous flow. If unable to achieve continuous flow (after five or six tries) the orifice fitting may be 'stripped'.

c) Reconnect the tubing to the deaeration pump nozzle and turn flow on.

d) Allow loading pressure to return to normal (18 to 25 psi).

NOTE: Recurring air locks may be indicative a 'stripped' orifice fitting, bad orifice o-rings or bad (intermittent) float switch.

TROUBLESHOOTING MOTORS

IMPORTANT! Proceed ONLY with the NOTED motor.

NOTE: If the motor shaft is turning but clockwise (when viewed from the motor end!) someone has misaligned the housing and motor cap. This can be corrected by turning the motor cap 180 degrees from its present location (see DEAERATION MOTOR BRUSHES in the PREVENTATIVE MAINTENANCE manual).

a) Assure that the NOTED motor is plugged into the correct distribution board position (see Table 1 below).

b) Wiggle the female distribution board connector and check if the motor starts rotating. If so there may be a bad connection inside the female connector.

c) Tap the motor with a screwdriver and check if the motor starts rotating. If so the brushes need replacing.

d) Assure that dialysate flow is on and set at the rate as directed in Table 1 below.

e) Unplug the motor from its distribution board position. Using a flashlight check inside the distribution board for 'white' corrosion (indicative of spillage).

f) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

g) If all pins are okay: set your meter to DC voltage and clip the leads, inside the distribution board, BETWEEN **male** pins 1 and 5 (top and bottom). **IMPORTANT!** Make certain of good meter connections. Place the red meter lead at pin 1 (top pin). Follow the directions given in Table 1.

Table 1 – Motor Troubleshooting

PUMP	DISTRIBUTION BOARD POSITION	FLOW RATE (ml/min)	VOLTAGE RANGE	BAD
DEAERATION	P20, DEGAS-P	500	16 vdc or greater	Replace the pump head
			Less than 16 vdc	Two Possibilities: 1. [1]Actuator cable 2. Actuator board
FLOW	P21, FLOW-P	800	12 vdc or greater	Replace the pump head
			Less than 12 vdc	Two Possibilities: 1. [2]Actuator cable 2. Actuator board

[1] The actuator cable can be checked for continuity. Note that you are checking **DEAERATION MOTOR** connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

[2] The actuator cable can be checked for continuity. Note that you are checking **FLOW MOTOR** connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

SECTION 2 - NO WATER

NW- 1.0.0 CHECK INCOMING WATER SYSTEM

a) Assure that the water is ON!

b) Assure that the vent tubing (back of machine) is not 'pinched' (see Figure 6, page 5).

c) Turn the water off and check the input water filter (if present) for restrictions (see Figure 6, page 5).

d) Before hooking the incoming water line back up assure that there is adequate incoming water flow (1 liter/min or greater).

e) Tee a pressure gauge at the output side of pressure regulator #61 (see Figure 16 below for location).

f) Turn the water on. Is gauge reading 18 psi or greater?

Yes Leave the gauge in place and see NW- 2.0.0

No Calibrate INLET WATER PRESSURE per CALIBRATION PROCEDURES. If unsuccessful a bad pressure regulator #61 is indicated.

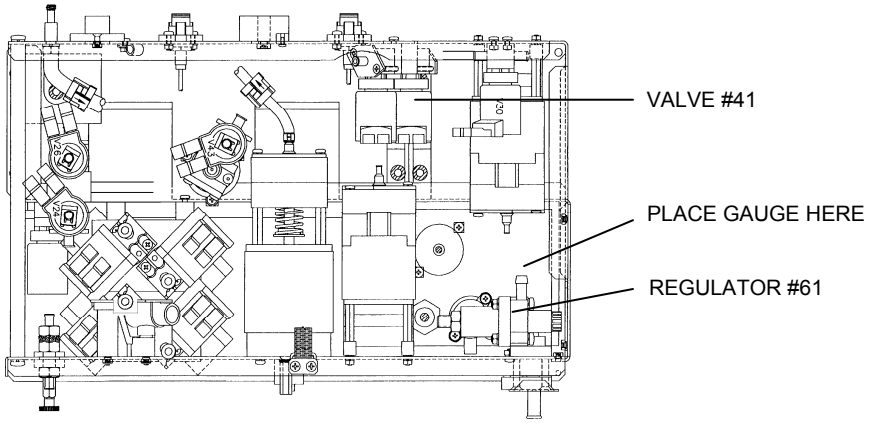


Figure 16 – Hydraulics (Top View)

NW- 2.0.0 CHECK FLOAT SIGNAL

a) Turn the water off.

b) Unplug the float connector from distribution board position x5, FLOAT-SW. Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage).

c) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

d) If all pins are okay: place a jumper wire, inside the distribution board, BETWEEN **male** pins 1 and 3 (top and middle). This simulates a 'closed' float switch. **IMPORTANT**! Make VERY sure of a good jumper connection!

e) Call debug screen 0. Is the circle next to valve #41 solid blue (indicating valve #41 is energized)?

Yes Leave the jumper in place and see NW- 2.0.1

No Two possibilities: 1) *Bad sensor board cable; 2) Bad actuator board.

*The sensor cable can be checked for continuity. Note that you are checking the FLOAT connection and proceed to SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

NW- 2.0.1 CHECK VALVE #41

Does the gauge at regulator #61 indicate low pressure (about 0 psi)?

Yes Bad float

No See NW- 3.0.0 (valve #41 is not opening)

NW- 3.0.0 CHECK FOR VALVE ERROR (VERR) AT VALVE #41

NOTE: Valve errors are caused by electrical current problems in a 'valve circuit'. If present, VERR (debug screen 1) increases (to a maximum of 255). If not present VERR remains 0. VERR is in the lower right corner of screen 1.

a) IMPORTANT. Turn the power off and then back on.

b) Place the machine into DIALYSIS program and QUICKLY enter debug screen 1. Is VERR increasing?

Yes A) Plug the float back into the distribution board (position x5, FLOAT-SW); B) Turn the water on; C) **NOTE** that you are in DIALYSIS program and there is a valve error at VALVE #41. Proceed to TROUBLESHOOTING VALVE ERRORS (page 31).

No Leave the jumper in place! A problem is indicated with the actuator board or VALVE #41. **NOTE** this and see TROUBLESHOOTING VALVES (page 30).

SECTION 3 - FLOW ERRORS IN CLEANING PROGRAMS

CLEAN- 1.0.0 CHECK FOR ERRORS IN DIALYSIS PROGRAM

This procedure determines if the flow error is occurring SPECIFICALLY in cleaning programs.

a) Pull the concentrate connectors out of their ports and plug into concentrate.

b) Place the machine in DIALYSIS PROGRAM.

NOTE: If the machine is locked in MANDATORY RINSE (i.e. after chemical disinfection, only RINSE is allowed) swap in another function board. To avoid calibration reference errors go into Service Mode and select YES for T and C (Test and Calibration) Mode on the Hardware Options screen. Remember to press the CONFIRM key to activate the change. When troubleshooting is complete, go back into Service Mode and select NO for T and C Mode then turn the power off and put the original function board back in.

c) Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch carefully for two minutes or until you see either a NO WATER alarm or a flow error (FLOW ERROR = "1"). Proceed accordingly:

- NO WATER alarm (intermittent or constant). Proceed to SECTION 2 - NO WATER (page 24).
- FLOW ERROR = "0" (constant). See CLEAN- 1.0.2
- FLOW ERROR = "1" (intermittent or constant). Proceed to SECTION 1 - FLOW ERRORS IN DIALYZE MODE (page 6)

CLEAN- 1.0.2 CHECK FOR FLOW ERRORS 'OUT OF BYPASS'

Allow temperature and conductivity to become normal (about eight minutes) so that the machine comes out of bypass (the bypass LED turns off). Carefully watch FLOW ERROR. Proceed accordingly:

- FLOW ERROR = "0" (constant). See CLEAN- 1.0.3.
- FLOW ERROR = "1" (intermittent or constant). Proceed to SECTION 1 - FLOW ERRORS IN DIALYZE MODE (page 6)

CLEAN- 1.0.3 CHECK FOR VALVE ERRORS (VERR)

a) Valve errors are caused by electrical current problems in a 'valve circuit'. If present, VERR (debug screen 1) increases (to a maximum of 255). If not present VERR remains 0.

b) During these procedures you will place the machine into a RINSE program and watch for a valve error (VERR). In RINSE debug is called by pushing the DOWN ARROW key ONLY. You need to enter debug and then call screen 1 (push the UP ARROW key) as quickly as you can. VERR is in the lower right hand corner.

c) At times you will also be asked to call and watch screen 0's valve #43 and #29. Become familiar with where these valves are located in the FLOW DIAGRAM! When a valve is energized the circle, next to the valve, turns solid blue.

d) Proceed to CLEAN- 1.0.4

CLEAN- 1.0.4 CHECK FOR A VALVE ERROR AT VALVE #39

a) IMPORTANT. Turn the power off and then back on.

b) Place the concentrate connectors back into their ports and place the machine into RINSE program

c) QUICKLY enter debug and call screen 1. Is VERR increasing?

Yes **NOTE** that you are in RINSE program and there is a valve error at VALVE #39. Proceed to TROUBLESHOOTING VALVE ERRORS (page 31)

No See CLEAN- 1.0.5

CLEAN- 1.0.5 CHECK FOR VALVE ERROR AT VALVE #43

QUICKLY return to screen 0 and watch V43. When it energizes call screen 1. Is VERR increasing?

Yes **NOTE** that you are in RINSE program and there is a valve error at VALVE #43. Proceed to TROUBLESHOOTING VALVE ERRORS (page 31)

No See CLEAN- 1.0.6

CLEAN- 1.0.6 CHECK FOR VALVE ERROR AT VALVE #29

QUICKLY return to screen 0 and watch V29. When it energizes call screen 1. Is VERR increasing?

Yes **NOTE** that you are in RINSE program and there is a valve error at VALVE #29. Proceed to TROUBLESHOOTING VALVE ERRORS (page 31)

No See CLEAN- 2.0.0

CLEAN- 2.0.0 CHECK VALVE #39

a) Interrupt the RINSE program by pulling the ACID connector from its port.

b) Connect a gauge in line at the INPUT side of the deaeration pump (see Figure 17, page 28).

c) Place the ACID connector back into its port and place the machine into RINSE. Is gauge pressure less than –14 inHg?

Yes See CLEAN- 2.0.1

No A problem is indicated with the actuator board or VALVE #39. **NOTE** this and see TROUBLESHOOTING VALVES (page 30).

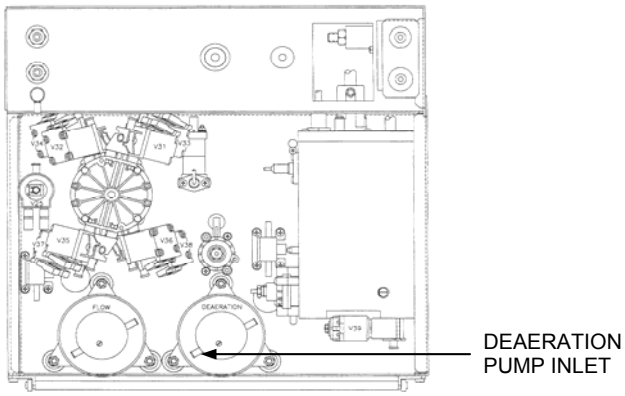


Figure 17 – Hydraulics (Rear View)

CLEAN- 2.0.1 CHECK VALVE #29

a) Interrupt the RINSE program by pulling the ACID connector from its port.

b) Clamp the clear tubing at the input nozzle of valve 29, as close to the valve as possible (see Figure 18 below), and remove the tubing from the valve.

c) Fill a syringe with water with tubing attached the same size as the input nozzle of valve 29. Attach the tubing to the input nozzle of valve 29.

d) Place the ACID connector back into its port and place the machine into RINSE.

e) Call debug screen 0, when V29 is energized (circle solid blue) try to push water through the valve. Are you able to push water through the valve?

Yes See CLEAN- 2.0.2

No A problem is indicated with the actuator board or VALVE #29. **NOTE** this and see TROUBLESHOOTING VALVES (page 30).

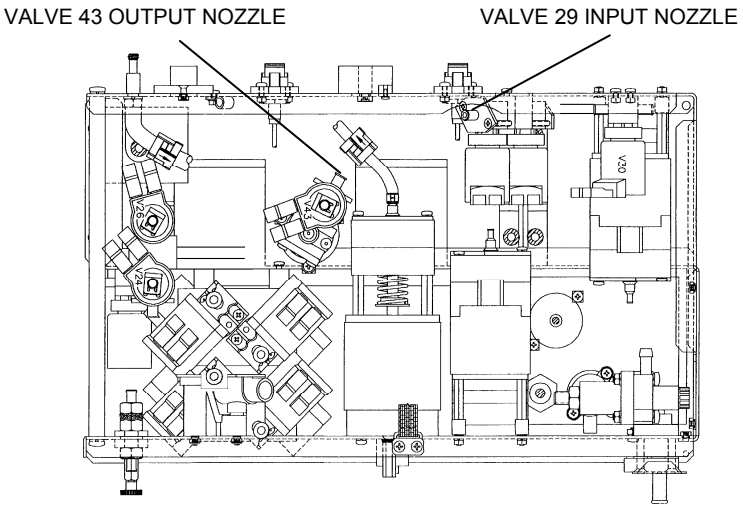


Figure 18 – Hydraulics (Top View)

CLEAN- 2.0.2 CHECK VALVE #43

a) Connect the tubing back to valve #29 and REMOVE the clamp.

b) Clamp and remove the output tubing from valve #43 (see Figure 18, on previous page).

c) From debug screen 0, when V43 is energized (circle solid blue) is there good 'pulsing' flow from the nozzle?

Yes See CLEAN- 2.0.3

No A problem is indicated with the actuator board or VALVE #43. **NOTE** this and see TROUBLESHOOTING VALVES (page 30).

CLEAN- 2.0.3 CHECK ACTUATOR BOARD SIGNAL

a) Place the machine into DIALYSIS PROGRAM and unplug valve #30 from its distribution board position (V30, DRAIN-V). Using a flashlight check inside the distribution board for 'white' corrosion (indicative of spillage).

b) If no corrosion: set your voltage meter to DC volts. Clip the leads BETWEEN **male** pins 1 and 5 (top and bottom) inside the distribution board. Place the red lead on pin 5 (bottom). Less than 2 volts?

Yes Replace valve #30.

No Replace the actuator board.

CLEAN- 3.0.0 CHECK FLOW ERROR

Place the machine into whatever cleaning program the flow error was occurring. If the flow error is still present. Possibilities:

- Bad deaeration motor brushes (especially if they have not been replaced in the last 8000 hours).
- Bad deaeration pump head.
- Bad (intermittent) dialysate pressure transducer #9.

TROUBLESHOOTING VALVES

The troubleshooting procedure that brought you here asked you to NOTE which valve is the problem.

Proceed **ONLY** with the **NOTED** valve!

a) Unplug the **NOTED** valve from its distribution board position as instructed in Table 2 below. Using a flashlight check inside the distribution board for 'white' corrosion (indicative of spillage).

b) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

c) If all pins are okay: set your voltage meter to DC volts. Clip the leads, inside the distribution board, BETWEEN **male** pins 1 and 5 (top and bottom). Clip the red lead on pin 5 (bottom).

d) Some valves are checked from RINSE program, others in DIALYSIS program as instructed in the table below. Place the machine into the indicated program.

e) Call debug screen 0. The valve is 'energized' when the circle (next to the valve) is solid blue. In RINSE program some valves are 'energized' only at certain times. Take the voltage measurement ONLY when the valve is energized.

Table 2 – Troubleshooting Valves

VALVE	DISTRIBUTION POSITION	PROGRAM MODE	GOOD (22 to 26 Volts DC)	BAD (0 to 22 Volts DC)
24	V24, DIAL-V1	RINSE	Valve #24 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
26	V26, BYPASS-V	RINSE	Valve #26 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
29	V29, REC-V	RINSE	Valve #29 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
43	V43	RINSE	Valve #43 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
25	V25, DIAL-V2	RINSE	Valve #25 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
39	V39, DEAR-V	RINSE	Valve #39 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
41	V27	DIALYSIS	Valve #41 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board
30	V30, DRAIN-V	DIALYSIS	Valve #30 bad or restricted	Two possibilities: 1) [1]Bad actuator cable 2) Bad actuator board

[1] The actuator cable can be checked for continuity. Note that you are checking **DEAERATION PUMP** connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

TROUBLESHOOTING VALVE ERRORS

Valve errors indicate a resistance problem in a 'valve circuit' and are generated when the actuator board tries to 'energize' that valve's solenoid. The easiest (and best) place to check is at the actuator board.

a) **IMPORTANT!** Turn the power off and slide electronic card cage forward.

b) Clip a ground lead onto PGND-B at the motherboard's TEST connector (see Figure 19 below). If the –12 volt converter board is plugged in here remove it for now. **IMPORTANT!** Make sure to reinstall the –12 volts converter correctly before placing the machine back into service.

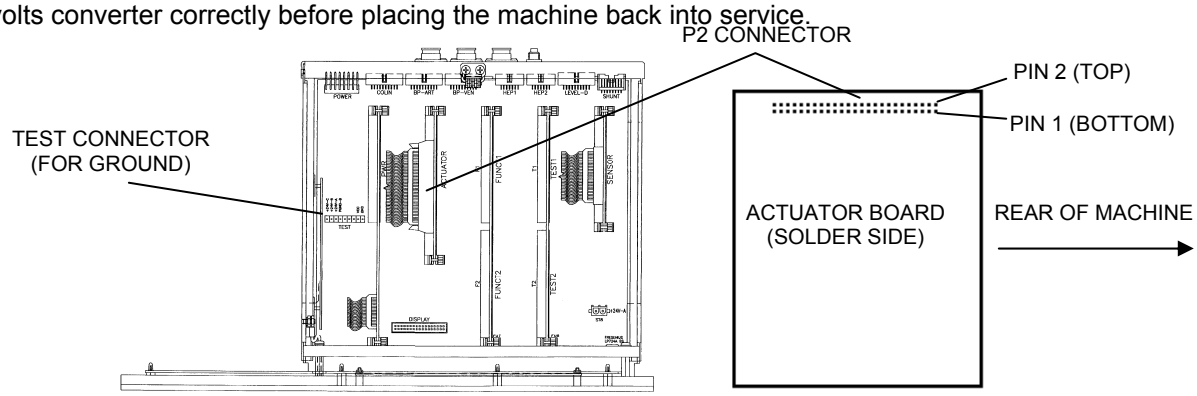


Figure 19 – Electronic Card Cage

c) At the top of the actuator board (second board from the left) there is a 50-pin connector called 'P2' (see Figure 19 above). The actuator ribbon-cable terminates here. Assure the cable is plugged in properly.

d) The actuator cable runs into the distribution board and terminates at the ACTUATOR connector. Assure the cable is plugged in properly at the distribution board.

e) Check the actuator ribbon-cable for damage along its entire length. Replace if damaged.

f) From the solder (back) side of the actuator board's 'P2' connector note that there are two rows of pins. All 'odd' numbered pins (1, 3, 5, etc) are in the bottom row. The 'even' numbered pins (2, 4, 6, etc) are in the top row. Each 'valve circuit' will be checked by measuring resistance from these pins. It will be easier to use a meter 'probe' instead of a clip-on lead!

g) The troubleshooting procedure that brought you here asked you to note which machine program the valve error is occurring. Is the VALVE ERROR occurring in RINSE or DIALYSIS program?

DIALYSIS See VE- 1.0.0

RINSE See VE- 2.0.0

VE- 1.0.0 VALVE ERRORS OCCURING IN DIALYSIS

CAUTION! If VERR reaches 255 (its maximum) the valve error cannot be determined. If VERR reaches 255 turn the power off, back on, return to DIALYSIS program and continue from where you left off.

a) Turn the power on and place the machine into DIALYSIS program.

b) Call debug screen 1. If VERR is not increasing do NOT continue!

c) Allow 20 seconds and call screen 0. Is a NO WATER ALARM indicated?

Yes See VE- 1.0.1

No See VE- 1.0.2

VE- 1.0.1 VALVE ERROR AT VALVE #41

A NO WATER alarm is indicated.

a) **IMPORTANT!** Turn the power off.

b) Set your meter to resistance (**Ω**) and measure from the solder (back) side pin, of the actuator board 'P2' connector, as directed in Table 3 below. **IMPORTANT!** A reading like 2.42 MΩ is 2.42 million Ohms.

Table 3 – Troubleshooting Valve Error at Valve #41

VALVE	PIN	P2 PIN LOCATION	GOOD = BETWEEN 40 Ω AND 100 Ω	BAD = LESS THAN 40 Ω OR GREATER THAN 100 Ω
41	32	Top row, 10 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0

VE- 1.0.2 VE- 1.0.1 CHECK FOR A VALVE ERROR AT VALVE #25

a) Call debug screen 1.

b) Open the shunt door (to closes valve #25). Does VERR stop increasing (and not = 255)?

Yes See VE- 1.0.3

No See VE- 1.0.4

VE- 1.0.3 VALVE ERROR AT VALVE #25

VERR stopped increasing when you opened the shunt door.

a) **IMPORTANT!** Turn the power off.

b) Set your meter to resistance (**Ω**) and measure from the solder (back) side pin, of the actuator board 'P2' connector, as directed in the table below. **IMPORTANT!** A reading like 2.42 MΩ is 2.42 million ohms!

Table 4 - Troubleshooting Valve Error at Valve #25

VALVE	PIN	P2 PIN LOCATION	GOOD = BETWEEN 40 Ω AND 100 Ω	BAD = LESS THAN 40 Ω OR GREATER THAN 100 Ω
25	30	Top row, 11 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0

VE- 1.0.4 VE- 1.0.2 CHECK FOR A VALVE ERROR AT A BALANCING CHAMBER VALVE

Turn dialysate flow off (flow on/off LED on). This closes all eight balancing chamber valves. Does VERR stop increasing (and not = 255)?

Yes See VE- 1.0.5

No See VE- 1.0.6

VE- 1.0.5 VALVE ERROR AT BALANCING CHAMBER VALVES

VERR stopped increasing when you turned dialysate flow off.

a) **IMPORTANT!** Turn the power off.

b) Set your meter to resistance (**Ω**) and measure from the solder (back) side pins, of the actuator board 'P2' connector, as directed in the table below. **IMPORTANT!** A reading like 2.42 MΩ is 2.42 million ohms!

Table 5 - Troubleshooting Valve Error at Balancing Chamber Valves

VALVE	PIN	P2 PIN LOCATION	GOOD = BETWEEN 40 Ω AND 100 Ω	BAD = LESS THAN 40 Ω OR GREATER THAN 100 Ω
31	36	Top row, 8 pins from front	Check also valve #32	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
32	37	Bottom row, 7 pins from front	Check also valve #33	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
33	38	Top row, 7 pins from front	Check also valve #34	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
34	39	Bottom row, 6 pins from front	Check also valve #35	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
35	40	Top row, 6 pins from front	Check also valve #36	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
36	41	Bottom row, 5 pins from front	Check also valve #37	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
37	42	Top row, 5 pins from front	Check also valve #38	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
38	43	Bottom row, 4 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0

VE- 1.0.6 VALVE ERROR AT VALVE #30 OR VALVE #26

VERR continued to increase with the shunt door open and with dialysate flow off.

a) **IMPORTANT!** Turn the power off.

b) Set your meter to resistance (**Ω**) and measure from the solder (back) side pins, of the actuator board 'P2' connector, as directed in the table below. **IMPORTANT!** A reading like 2.42 MΩ is 2.42 million ohms!

Table 6 - Troubleshooting Valve Error at Valve #30 or Valve #26

VALVE	PIN	P2 PIN LOCATION	GOOD = BETWEEN 40 Ω AND 100 Ω	BAD = LESS THAN 40 Ω OR GREATER THAN 100 Ω
30	35	Bottom row, 8 pins from front	Check also valve #26	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
26	31	Bottom row, 10 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0

VE- 2.0.0 VALVE ERRORS OCCURRING IN RINSE

The troubleshooting procedures in SECTION 3 - FLOW ERRORS IN CLEANING PROGRAMS asked you to note where valve error is occurring. Proceed ONLY with that valve.

a) **IMPORTANT!** Turn the power off.

b) Set your meter to resistance (**Ω**) and measure from the solder (back) side pin, of the actuator board 'P2' connector, as directed in the table below. **IMPORTANT!** A reading like 2.42 MΩ is 2.42 million ohms!

Table 7 - Troubleshooting Valve Errors Occurring in Rinse

VALVE	PIN	P2 PIN LOCATION	GOOD = BETWEEN 40 Ω AND 100 Ω	BAD = LESS THAN 40 Ω OR GREATER THAN 100 Ω
39	44	Top row, 4 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
29	34	Top row, 9 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0
43	46	Top row, 3 pins from front	Replace the actuator board	Greater than 100 Ω, See VE- 3.0.0 Less than 40 Ω, See VE- 4.0.0

VE- 3.0.0 CHECK FOR AN 'OPEN' (GREATER THAN 100 Ω) VALVE CIRCUIT

a) Verify that the **NOTED** valve is plugged into the correct location on the distribution board (for example, valve 36 plugs into position V36). Note that valve 41 plugs into the position labeled 27IN-V.

b) Unplug the **NOTED** valve from its distribution board position. Using a flashlight, check inside the distribution board, for 'white' corrosion (indicative of spillage).

c) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

d) If all pins are okay: open the female connector's, plastic, cover and check for good solder connections.

e) Leaving the connector unplugged measure resistance, inside the **female** connector, between pins 1 and 5 (where the wires are soldered). Note that valve 26 is wired to pins 2 and 5. Is the resistance between 40 and 100 Ω?

Yes See VE- 3.0.1

No See VE- 3.0.2

VE- 3.0.1 CHECK ACTUATOR BOARD CABLE

a) Unplug the 50-conductor actuator cable from both ends (the cable terminates at actuator board and at the distribution board's ACTUATOR connector).

b) Using a flashlight, check the **male** side of both connectors for 'white' corrosion (indicative of spillage).

c) If no corrosion: check for bent or broken **male** pins.

d) If all pins are okay: replace the actuator cable.

VE- 3.0.2 CHECK VALVE SOLENOID

Each valve has a two-wire harness that runs from the distribution board and terminates at its solenoid where it plugs onto two male terminals (see Figure 20 and Figure 21 below to locate the valve). Unplug the two-wire harness and measure between the **male** solenoid terminals. Between 40 and 100 Ω?

Yes The two-wire harness is bad.

No Replace the valve.

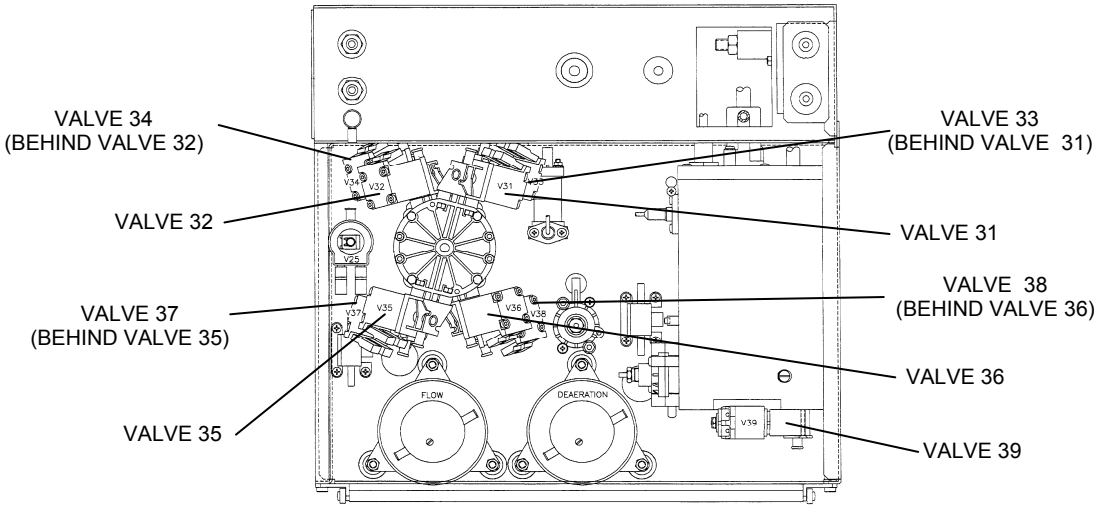


Figure 20 – Hydraulics (Rear View)

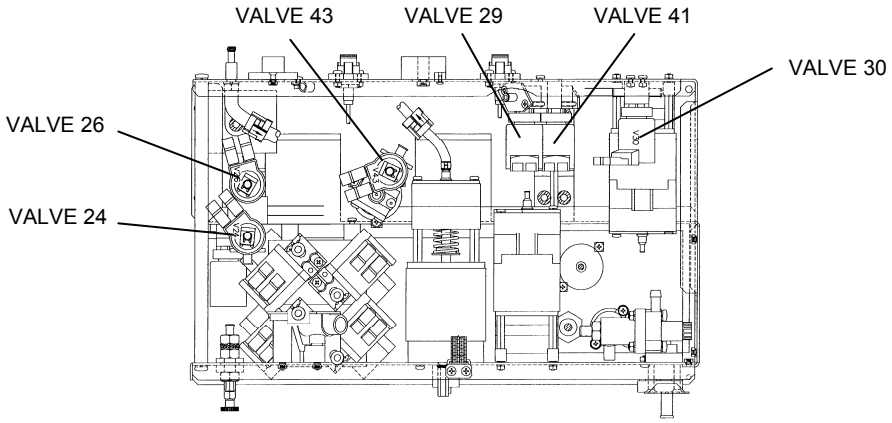


Figure 21 – Hydraulics (Top View)

VE- 4.0.0 CHECK FOR A 'SHORTED' (LESS THAN 40 Ω)VALVE CIRCUIT

IMPORTANT! A previous reading like 2.42 MΩ is 2.42 million ohms! A reading like 2.42 KΩ is 2.42 thousand ohms. Make CERTAIN that you are reading the meter correctly before continuing with these procedures!

a) Assure that the **NOTED** valve is plugged into the distribution board at the correct location (for example, valve 36 plugs into position V36).

b) Unplug the **NOTED** valve from its distribution board position. Using a flashlight check, inside the distribution board, for 'white' corrosion (indicative of spillage).

c) If no corrosion: do NOT plug the valve into the distribution board yet. Measure resistance again at the **NOTED** valve's actuator board 'P2' connector pin (as instructed in the table). Greater than 2 MΩ (possibly O.L., depends on meter)?

Yes Replace the valve (shorted solenoid). See Figure 20 and Figure 21 (on previous page), to locate the valve.

No See VE- 4.0.1

VE- 4.0.1 CHECK ACTUATOR BOARD FOR A 'SHORT'

Unplug the 50-conductor actuator ribbon-cable from the actuator board and measure resistance again at the **NOTED** valve's actuator board 'P2' connector pin (as instructed in the table). Greater than 2 MΩ (possibly O.L., depends on meter)?

Yes Using a flashlight check, inside the actuator board **male** connector, for bent or broken pins. If okay: replace the actuator board (shorted valve driver).

No See VE- 4.0.2

VE- 4.0.2 CHECK ACTUATOR BOARD CABLE CONNECTIONS

a) Using a flashlight check, inside the actuator board **male** connector, for bent or broken pins. If okay, plug the actuator cable back into the actuator board.

b) Unplug the 50-conductor actuator ribbon-cable from the distribution board's ACTUATORS connector. Using a flashlight check, inside the distribution board's ACTUATOR connector, for 'white' corrosion (indicative of spillage).

c) If no corrosion: check, inside the distribution board's ACTUATOR connector, for bent or broken **male** pins.

d) If all pins are okay: measure resistance again at the **NOTED** valve's actuator board 'P2' connector pin (as instructed in the table). Greater than 2 MΩ (possibly O.L., depends on meter)?

Yes See VE- 4.0.3

No Replace the actuator ribbon-cable.

VE- 4.0.3 CHECK ACTUATOR CONNECTOR PINS/ VALVE HARNESS

a) Check the 2-pin wiring harness that runs from the NOTED valve's distribution board connector to the valve, for exposed wire.

b) Plug the actuator cable back the distribution board's ACTUATORS connector.

c) Plug the valve back into the distribution board. **IMPORTANT!** Be SURE to plug the valve into the correct position!

d) Measure resistance again at the **NOTED** valve's actuator board 'P2' connector pin (as instructed in the table). Between 40 and 100Ω?

Yes There may have been a bad connection at the distribution board.

No VE- 4.0.4

VE- 4.0.4 CHECK VALVE SOLENOID

a) Locate the noted valve (use Figure 20 and Figure 21 on page 36).

b) Unplug the two-wire distribution board harness directly from the solenoid.

c) Measure resistance BETWEEN the solenoid terminals.). Between 40 and 100Ω?

Yes Possible: 1) Bad actuator cable; 2) Bad two-wire valve harness; 3)Bad actuator board; 4) Bad distribution board

No Replace the valve.

SECTION 4 - TEMPERATURE PROBLEMS

Read the following list of symptoms and proceed with the one that best describes the problem:

1. Machine is in DIALYSIS program and:
    - Temperature remains less than 30°C. See T- 1.0.0.
    - Temperature increases to about 40°C falls and rises again. See T- 4.0.0.
2. You are attempting HEATER CONTROL CALIBRATION and:
    - Temperature stabilizes but will not calibrate to 37°C. Return to DIALYSIS program and see T- 1.0.0.
    - Temperature increases to about 40°C falls and rises again. Return to DIALYSIS program and see T- 4.0.0.
3. Machine is HEAT DISINFECT program and:
    - Temperature remains less than 30°C. Return to DIALYSIS program and see T- 1.0.0.
    - Temperature fails to reach 80°C but is greater than 30ºC. See T- 3.0.0.
    - Temperature increases to about 90°C falls and then rises again. See T- 4.0.0.

T- 1.0.0 CHECK HEATER BREAKER AND NO WATER AND FLOW ERROR

a) Make sure the heater breaker switch (rear panel) is on. If not this is the problem!

b) Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch for two minutes or until you see either a NO WATER alarm or a flow error (FLOW ERROR = "1"). Proceed accordingly:

- NO WATER alarm (intermittent or constant). See SECTION 2 - NO WATER (page 24).
- FLOW ERROR = "0" (constant). See T- 1.0.1
- FLOW ERROR = "1" (intermittent or constant). See SECTION 1- FLOW ERRORS IN DIALYZE MODE (page 6).

T- 1.0.1 CHECK TEMPERATURE SET POINT

a) Push the blue HOME screen button to return to the main screen

b) Push the yellow Temperature data button (it turns a dark yellow). Now displayed is the current Temp. Setting. Is temperature set okay (per unit standards)?

Yes Push the CONFIRM key and see T-1.0.2

No Use the UP or DOWN arrow keys to adjust and push the CONFIRM key. Allow 10 minutes for stabilization.

T- 1.0.2 CHECK HEATER VOLTAGE

CAUTION 120 VOLTS! Carefully measure ac (~) voltage, BETWEEN the **BLUE** and **BROWN** heater wires at the distribution board's heater connector (see Figure 22 below). Voltage may be 'pulsing' causing the meter to overload (O.L.) intermittently (this is normal). Greater than 90 volts?

Yes See T- 1.0.3

No See T- 2.0.0

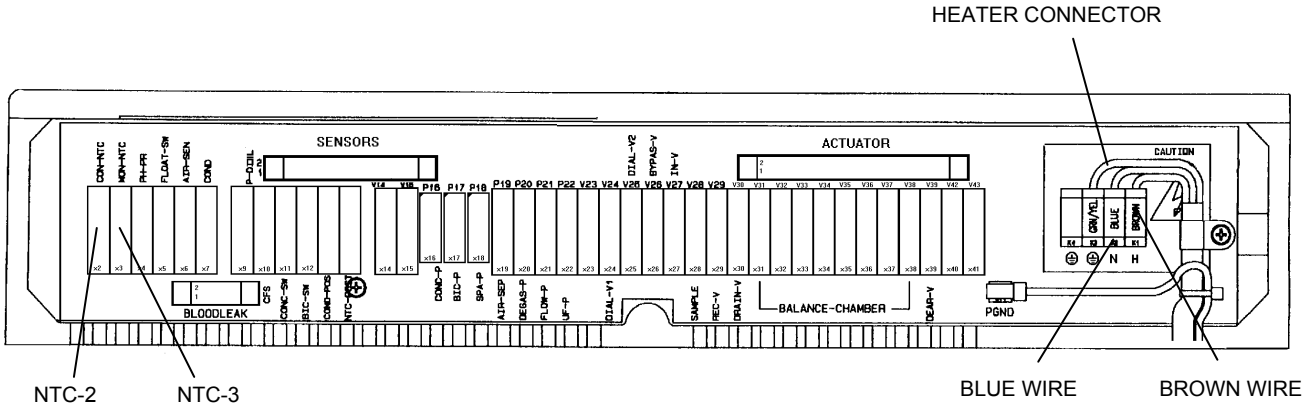


Figure 22 – Distribution Board

T- 1.0.3 CHECK HEATER

IMPORTANT turn the POWER OFF! Measure RESISTANCE (Ω) between the **BLUE** and **BROWN** heater wires (see Figure 22 above). Between 9 and 13 Ω?

Yes See T- 5.0.0 (page 51).

No Replace the heater.

T- 2.0.0 CHECK LOGIC SIGNALS

CAUTION! During these procedures, DC voltages are measured at the solder (back) side of the POWER LOGIC BOARD'S 'x2' connector. The pins are very close to each other and 'shorting' them together with a meter probe can damage the board. It is recommended that you use Fluke TP80 meter probes together with the slip-on cap (see Figure 5 on page 4).

a) Turn the power off and clip a ground lead onto SGND at the TEST connector (see Figure 23 below).

b) At the top, very front of the POWER LOGIC BOARD (first board from the left) is the 20-pin 'x2' connector (see Figure 23 below). A ribbon cable terminates here that runs into the power supply. The solder (rear) side pins are in two rows. In the top row are even numbered (2, 4, etc) pins, in the bottom row are odd (1, 3, etc) numbered pins.

c) Turn power on and place the machine into DIALYSIS PROGRAM. Wait 20 seconds and measure DC voltage at the pins specified in the Table 8 below. Follow the directions given in Table 8.

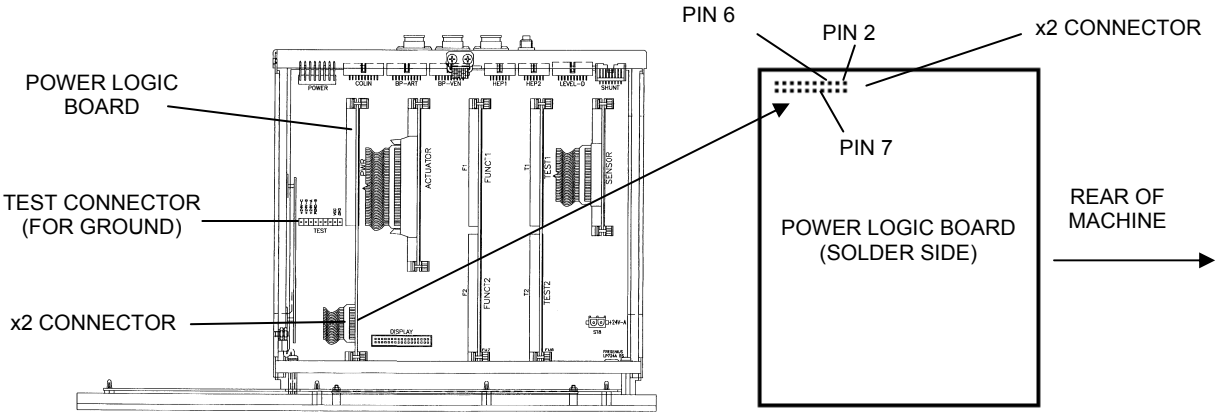


Figure 23 – Electronic Card Cage

Table 8 – Logic Signals

PIN	x2 LOCATION	GOOD SIGNAL (volts dc)	BAD SIGNAL (volts dc)
6	top row, three pins from the rear	9.6 or greater, measure at x2, pin 7	3.6 or lower, see T- 2.1.0
7	bottom row, four pins from the rear	4 or greater, measure at x2, pin 2	3 or lower, see T- 2.2.0
2	top row, first pin from the rear	2 or lower, see T- 2.4.0	9 or higher, see T- 2.3.0

T- 2.1.0 CHECK SENSOR BOARD SIGNAL

a) At the very BOTTOM of the **SENSOR** board (first board on the right) is its motherboard connector (see Figure 24 below). A row of pins extends horizontally from the board, turn 90 degrees downward and runs into the motherboard connector. This is the "C row", numbered 1 through 32 (from front-to-rear).

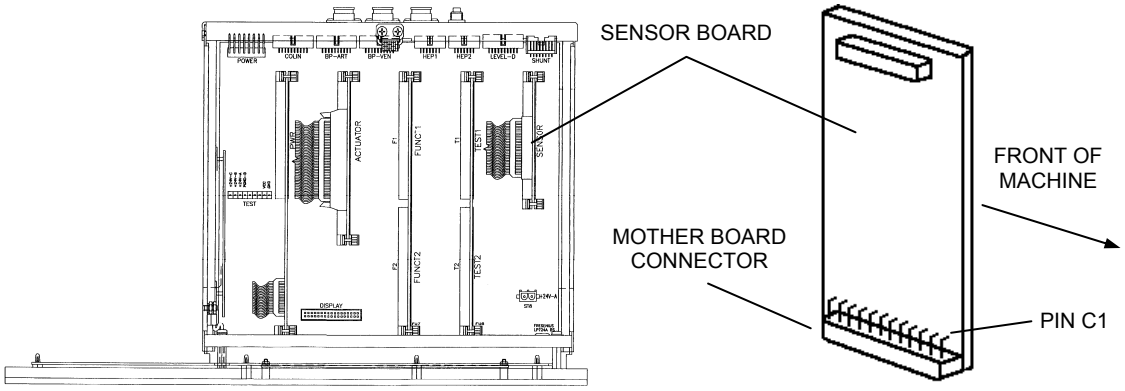


Figure 24 – Electronic Card Cage

b) Do NOT use the slip on cap: measure DC voltage at pin C1 (very FRONT motherboard pin). High (9.6 volts or greater) or low (less than 3.6 volts)?

High See T- 2.1.2

Low See T- 2.1.1

T- 2.1.1 CHECK POWER LOGIC BOARD

a) Turn the power off and swap in a known good power logic board.

b) Turn the power on and measure at the power logic board's x2 connector, pin 6. High (9.6 volts or greater) or low (3.6 volts or lower)?

High Problem solved (the previous power logic board is bad)

Low See T- 2.5.0 (the previous power logic board is good)

T- 2.1.2 CHECK NTC-2

Unplug NTC-2 from the distribution board (first position on left, x2 CON-NTC) and measure again at pin C1. High (9.6 volts or greater) or low (less than 3.6 volts)?

Low Replace NTC-2.

High See T- 2.1.3.

T- 2.1.3 CHECK NTC-2 CIRCUIT

a) Turn the power off and unplug both ends of the 34-conductor sensor board cable. Using a flashlight, check for bent, broken or corroded **male** pins at each connector.

b) If no corrosion: plug both ends of the cable back in and swap in a known good power logic board.

c) Turn the power back on and measure again at the sensor board's motherboard pin C1. High (9.6 volts or greater) or low (3.6 volts or lower)?

High Replace the sensor board (the previous power logic board is good).

Low Problem solved (the previous power logic board is bad).

T- 2.2.0 CHECK FOR FLOW ERRORS

Call debug screen 0. Is FLOW ERROR = "1"?

Yes See SECTION 1- FLOW ERRORS IN DIALYSIS PROGRAM (page 6).

No See T- 2.2.1

T- 2.2.1 CHECK ACTUATOR BOARD

a) Turn the power off and swap in a known good actuator board.

b) Turn the power on and place the machine into DIALYSIS PROGRAM.

c) Measure again at the power logic board's 'x2' connector, pin 7 (bottom row, 4 pins from rear). High (greater than 4 volts) or low (less than 1.5 volts)?

High The previous actuator board is bad.

Low See T- 2.5.0 (the previous actuator board is good).

T- 2.3.0 CHECK POWER LOGIC/FUNCTION BOARD

a) Turn the power off and swap in a known good power logic board.

b) Turn the power on and place the machine into DIALYSIS PROGRAM.

c) Wait 15 seconds and measure again at the solder side of the power logic board's 'x2' connector, pin 2 (top row, first pin from rear). Less than 2 volts now?

Yes The previous power logic board was bad.

No Replace the function board (the previous power logic board is good).

T- 2.4.0 CHECK HEATER RELAY

a) Turn the power off and then back on. Allow the SELECT PROGRAM screen to come up. **IMPORTANT**! Do **NOT** enter dialysis program.

b) From SELECT PROGRAM measure again at the solder side of the power logic board's x2 connector, pin 2 (top row, first pin from rear). Between 22 and 26 volts?

Yes See T- 2.6.0.

No See T- 2.5.0

T- 2.5.0 CHECK POWER LOGIC CABLE/POWER CONTROL BOARD

Either the 20-pin power logic board cable or the power control board is bad.

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VOLTS IF NOT UNPLUGGED!**

b) Slide the power supply (see Figure 6, page 5) away from the cabinet. Inside is the power control board where the 20-pin 'x2' cable terminates. Check that the cable is plugged in properly.

c) Un-mount the power control board from the plastic clips to allow easy access to the rear (solder) side (see Figure 25 below).

d) Measure resistance from pin 2, at the POWER LOGIC BOARD'S end of the cable (x2 connector, top row, first pin from rear), to pin 2 at the POWER CONTROL BOARD'S end. If the cable is good (10 Ω or less), replace the POWER CONTROL BOARD.

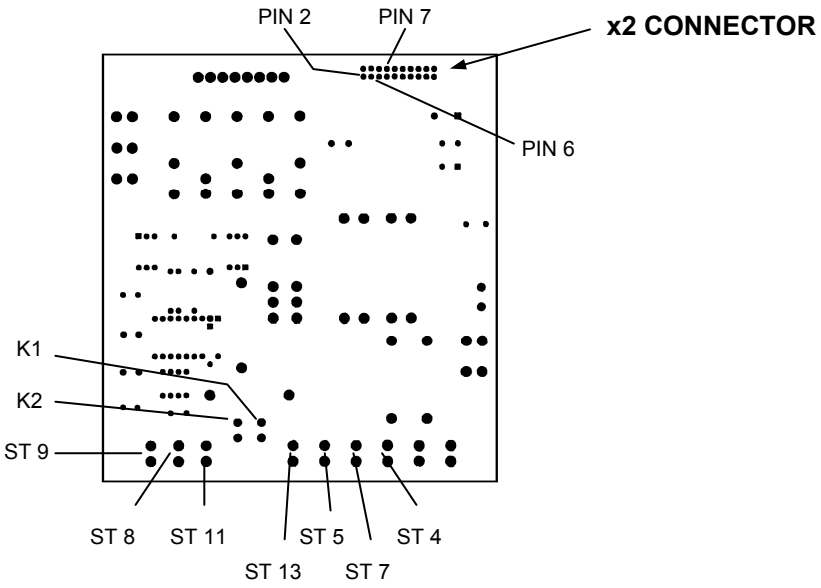


Figure 25 – Power Control Board (Solder Side)

T- 2.6.0 CHECK POWER LOGIC BOARD CABLE

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VOLTS IF NOT UNPLUGGED!**

b) Slide the upper power supply (see Figure 6, page 5) away from the cabinet. Inside is the power control board where the 20-pin 'x2' cable terminates. Check that the cable is plugged in properly.

c) Un-mount the power control board from the plastic clips to allow easy access to the rear (solder) side (see Figure 25 on previous page). Measure resistance (Ω) from:

   1) Pin 6, at the POWER LOGIC BOARD'S end of the cable ('x2' connector, top row, three pins from rear), to pin 6 at the POWER CONTROL BOARD'S end (see Figure 25 on previous page).
   2) Pin 7, at the POWER LOGIC BOARD'S end of the cable ('x2' connector, bottom row, four pins from rear), to pin 7 at the POWER CONTROL BOARD'S end (see Figure 25 on previous page).

d) If both measurements are good (10 Ω or less) see T- 2.6.1.

T- 2.6.1 CHECK TRIAC VOLTAGE DROP

a) Set meter to ac (~) volts and CLIP the leads, onto the SOLDER (rear) side of the power control board, BETWEEN connectors ST8 and ST11 (see Figure 25 on previous page).

b) Plug the machine in. **CAUTION, 120 VOLTS NOW PRESENT!**

c) Turn the power on and place the machine into DIALYSIS PROGRAM. Wait 15 seconds. Greater than 90 volts across the triac?

   Yes See T- 2.6.2

   No See T- 2.7.0

T- 2.6.2 CHECK TRIAC GATE SIGNAL

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VOLTS IF NOT UNPLUGGED!**

b) CLIP meter leads BETWEEN connectors K2 and ST9 on the SOLDER (rear) side of the power control board (see Figure 25 on previous page).

c) Plug the machine in. **CAUTION, 120 VOLTS NOW PRESENT!**

d) Turn the power on and place the machine into DIALYSIS PROGRAM. Wait 15 seconds. 90 volts or greater?

   Yes Bad power control board.

   No Bad triac (trace the orange wire from connector ST9 to the triac).

T- 2.7.0 CHECK HEATER CONNECTIONS

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VOLTS IF NOT UNPLUGGED!**

b) Measure resistance (Ω), on the SOLDER (rear) side of the power control board, BETWEEN connectors K2 and K1 (see Figure 25 on previous page). Less than 20 Ω?

   Yes See T- 2.7.1

   No Check for an open circuit between the power supply and the heater.

T- 2.7.1 CHECK HEATER BREAKER

Referring to Figure 25 on the page 44 measure resistance on the SOLDER (rear) side of the power control board, BETWEEN connectors:

- ST 7 and ST 13;
- ST 4 and ST 5.

Both measurements less than 30 Ω?

Yes See T- 2.7.2

No Bad heater breaker ('open')

T- 2.7.2 CHECK HEATER VOLTAGE

a) Turn the power on and place the machine into DIALYSIS PROGRAM.

b) **CAUTION 120 VOLTS!** Measure ac (~) voltage, between the **GREEN** and **BROWN** heater wires at the distribution board's heater connector (see Figure 26 below). Greater than 90 volts?

Yes All systems are checking good.

No Replace the power control board (inside power supply).

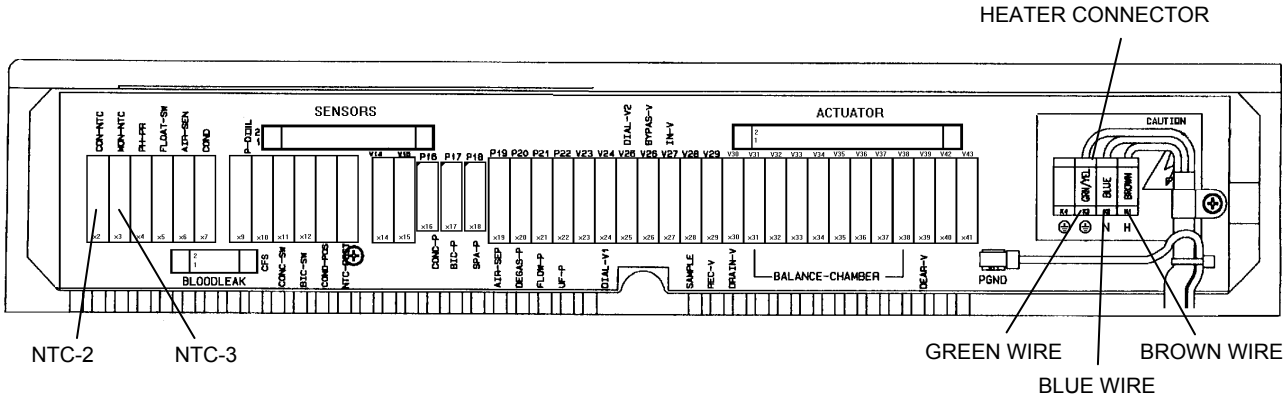


Figure 26 – Distribution Board

T- 3.0.0 CHECK TEMPERATURE DISPLAY

From HEAT DISINFECT, plug the 80°C Fresenius temperature 'dummy' connector into NTC-3 on the distribution board. Does the Temperature display (on the screen) read between 77°C and 85°C ?

Yes See T- 3.0.1

No See T- 6.0.0 (page 52)

T- 3.0.1 CHECK RECIRCULATION

a) Go to end of the drain tubing. Hold the tubing so that the opening is pointed **UPWARD!** (at about 45 degrees). **CAUTION!!** If the opening is held DOWNWARD this test is invalid.

b) Call debug screen 0. When V29 is energized the circle, next to the valve, turns solid blue. Wait until V29 is energized **CONSTANTLY**. Is there flow to the drain?

Yes See T- 3.0.2

No See T- 3.0.3

T- 3.0.2 CHECK VALVE #30

Unplug valve #30 from the distribution position V30. Using a flashlight check, inside the distribution board for corrosion (indicative of spillage). If no corrosion: does flow to the drain stop?

Yes Replace the actuator board (shorted driver).

No Replace valve #30 (leaking).

T- 3.0.3 CHECK HEATER

a) Turn the heater breaker switch (rear panel) off and wait 15 minutes.

b) Turn the POWER OFF and measure RESISTANCE (Ω), between the **BROWN** and **BLUE** heater wires at the distribution board's heater connector (see Figure 26 on previous page). Between 9 and 13 Ω?

Yes Note that NTC-2 **OR** NTC-3 may be a problem and see T- 9.0.0 (page 53).

No Replace the heater

T- 4.0.0 CHECK SENSOR BOARD SIGNAL

a) Turn the power off and clip a ground lead onto SGND at the TEST connector (see Figure 27 below).

NOTE: Troubleshooting this symptom **CANNOT** be done in HEAT DISINFECT. If in HEAT DISINFECT return to **DIALYSIS PROGRAM**.

b) Plug the 80°C Fresenius temperature 'dummy' connector into NTC-2's distribution board position (**FIRST!** position on the left, CON-NTC). **CAUTION!** Be careful to plug in correctly!

c) At the very BOTTOM of the **SENSOR** board (first board from the right) is its motherboard connector (see Figure 27 below). A row of pins extends horizontally from the board, turn 90 degrees downward and runs into the motherboard connector. This is the "C row", numbered 1 through 32 (from front-to-rear).

d) Turn the power on. Do NOT use the TP80 slip-on cap: measure DC voltage at pin C1 (very FRONT motherboard pin). High (9.6 vdc or greater) or low (less than 3.6 vdc)?

High Leave the 'dummy' in for now and see T- 4.1.0

Low Note that **NTC-2** may be a problem and see T- 9.0.0 (page 53).

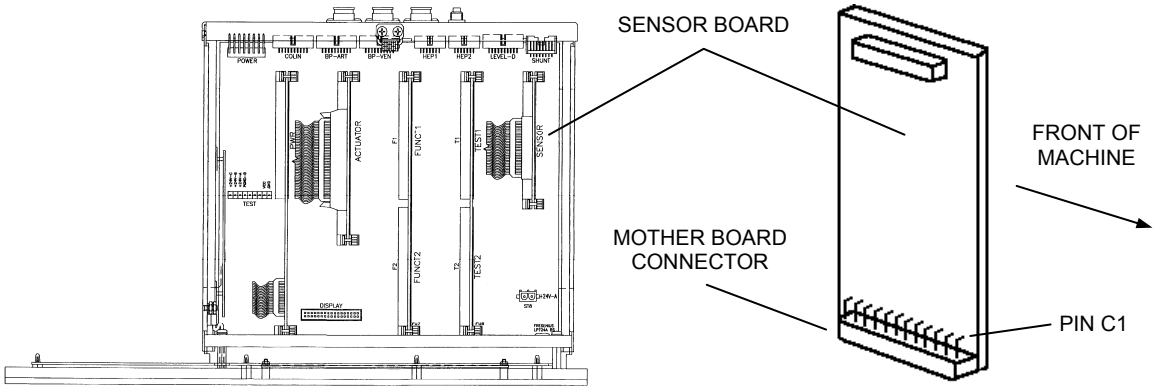


Figure 27 – Electronic Card Cage

T- 4.1.0 CHECK LOGIC SIGNAL

CAUTION! During this procedure, DC voltages are measured at the solder (back) side of the POWER LOGIC BOARD'S ‘x2’ connector. The pins are very close to each other and 'shorting' them together with a meter probe can damage the board. It is recommended that you use Fluke TP80 meter probes together with the slip-on cap (see Figure 5 on page 4).

a) At the top, very front of the POWER LOGIC BOARD (first board from the left) is the 20-pin 'x2' connector (see Figure 27 below). A ribbon cable terminates here that runs into the upper power supply. The solder (rear) side pins are in two rows. In the top row are even numbered (2, 4, 6, etc) pins, in the bottom row are odd (1, 3, 5, etc) numbered pins.

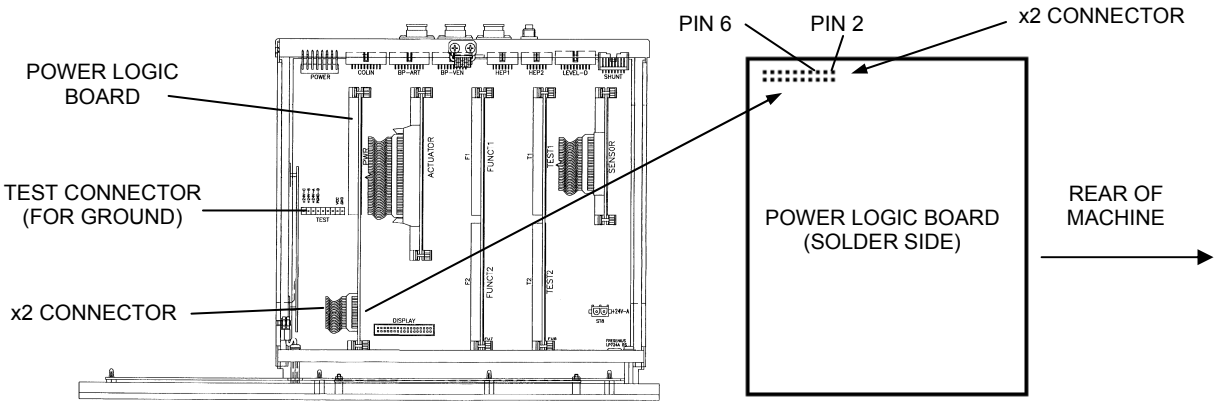


Figure 28 – Electronic Card Cage

b) Turn the power on and measure at the solder side of the x2 connector, pin 6 (top row, 3 pins from rear). High (greater than 9.6 volts) or low (less than 3.6 volts)?

High See T- 4.2.0

Low Watch the Temperature display (main screen) for **10 minutes**. Does it drop to 33°C?

Yes Replace NTC- 2

No Continues to increase, see T- 4.3.0

T- 4.2.0 CHECK POWER LOGIC BOARD

a) Turn the power off and swap the power logic board with a known good board.

b) Turn the power on and place the machine into DIALYSIS PROGRAM. Watch for 10 minutes. If Temperature continues to increase to about 40°C replace the power control board (inside the power supply).

T- 4.3.0 CHECK FOR A SHORTED TRIAC

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VAC IF NOT UNPLUGGED**!

b) Remove the power supply from the cabinet (see Figure 6, page 5). Inside the power supply is the power control board, which is mounted to the case with plastic clips. Remove the board from the clips to allow easier access to the back (solder) side of the board.

c) Measure RESISTANCE (Ω), on the solder side of the power control board, between connectors ST8 and ST11 (see SOLDER SIDE in Figure 29 below). Greater than 3 MΩ (or O.L.)?

Yes See T- 4.4.0

No Replace the triac.

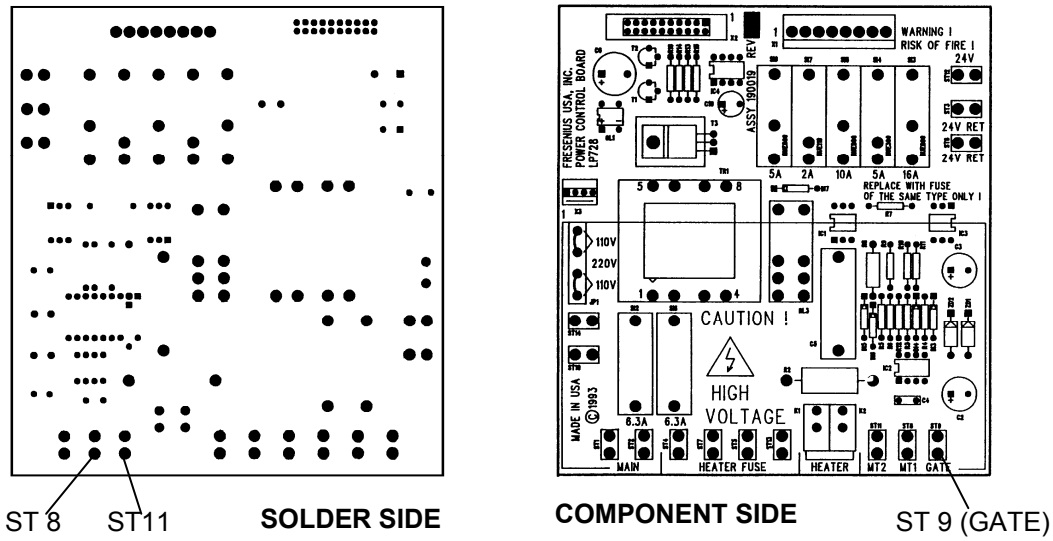


Figure 29 – Power Control Board

T- 4.4.0 CHECK TEMP CALIBRATION

a) Turn the power off and place the machine in SERVICE/CALIBRATION. Place a temperature meter into the dialysate lines to measure 'actual' temperature. **CAUTION** Fluid may be hot!

b) Turn the power back on and enter HEAT TEMP CONTROL. Lower the DAC value to "0".

c) Watch 'actual' (on the meter) temperature for 10 minutes. Continue to increase to high?

Yes Leave the temperature meter in line for now and see T- 4.5.0

No Plug NTC-2 back into the distribution board (first position from the left, CON-NTC) and calibrate HEATER TEMP CONTROL.

T- 4.5.0 REMOVE TRIAC'S GATE SIGNAL

a) Turn the power off and **UNPLUG** the machine. **CAUTION, 120 VOLTS IF NOT UNPLUGGED!**

b) Unplug the female terminal connector from the power control board's (GATE) terminal ST 9 (see COMPONENT SIDE in Figure 29 on previous page).

c) Wrap BLACK tape around the female terminal connector. CAUTION! The connector is 'live' (120 volts) when the power is on. Damage to the machine or risk of shock if not wrapped.

d) Plug the machine in **(CAUTION, 120 VOLTS NOW PRESENT!)**. Turn the power on and enter CALIBRATION/HEATER TEMP CONTROL.

f) Lower the DAC value to "0" and watch 'actual' (on the meter) temperature for 10 minutes. Continue to increase to about 40°C?

Yes Replace the triac and calibrate HEATER TEMP CONTROL.

No Replace the power control board and calibrate HEATER TEMP CONTROL.

T- 5.0.0 CHECK TEMP DISPLAY

With the machine on in DIALYSIS PROGRAM, plug the 40°C Fresenius test (temperature) 'dummy connector' into NTC-3's position (second position from the left, MON-NTC). **CAUTION!** Plug in correctly. Does the Temperature display (main screen) read between 38°C and 42°C?

Yes Note that **NTC- 3** may be a problem and see T- 9.0.0 (page 53).

No See T- 6.0.0.

T- 6.0.0 CHECK DEBUG TEMPERATURE VALUES

a) With the 40°C connector plugged call debug screen 4 and note:

- TEMP (Good = 8.8 +/- 0.3 volts)
- ATEM (Good = 7.7 +/- 0.3 volts)

b) Refer to the table below and follow the directions given.

Table 9 – Debug Temperature Values

DEBUG 4, TEMP	DEBUG 4, ATEM	RESPONSE
GOOD	GOOD	See T- 7.0.0
GOOD	BAD	Replace the actuator board
BAD	GOOD	Replace the sensor board
BAD	BAD	See T- 8.0.0

T- 7.0.0 CALIBRATE TEMPERATURE

a) Plug NTC-3 back into distribution board (**SECOND!** position from left, x3 MON-NTC). **CAUTION!** Be sure to plug in correctly.

b) Calibrate HEATER TEMP CONTROL per CALIBRATION PROCEDURES. If not successful note that either NTC- 2 **or** NTC- 3 may be a problem and see T- 9.0.0.

T- 8.0.0 CHECK TEST BOARD

a) Turn the machine off and swap in a known good test board. **NOTE**: An alternative is to remove IC 4 from the test board. The machine runs okay without IC4 but will not pass tests.

b) Turn the power on and place the machine into DIALYSIS program. With the 40°C dummy connector plugged in call debug screen 4. TEMP = 8.8 (+/- 0.3) volts?

Yes The previous test board (or IC 4, test board) is bad.

No Four possibilities: 1) *Bad sensor board cable; 2) HEATER TEMP CONTROL not calibrated accurately; 3) Bad sensor board; 4) Bad function board.

*The sensor cable can be checked for continuity. Note that you are checking **NTC-2 and NTC-3** connections and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

T- 9.0.0 CHECK NTC RESISTANCE

Proceed **ONLY** with the NTC(s) as noted above.

a) Turn the **POWER OFF** and remove the NTC(s) from their respective hydraulic location (see Figure 30 below).

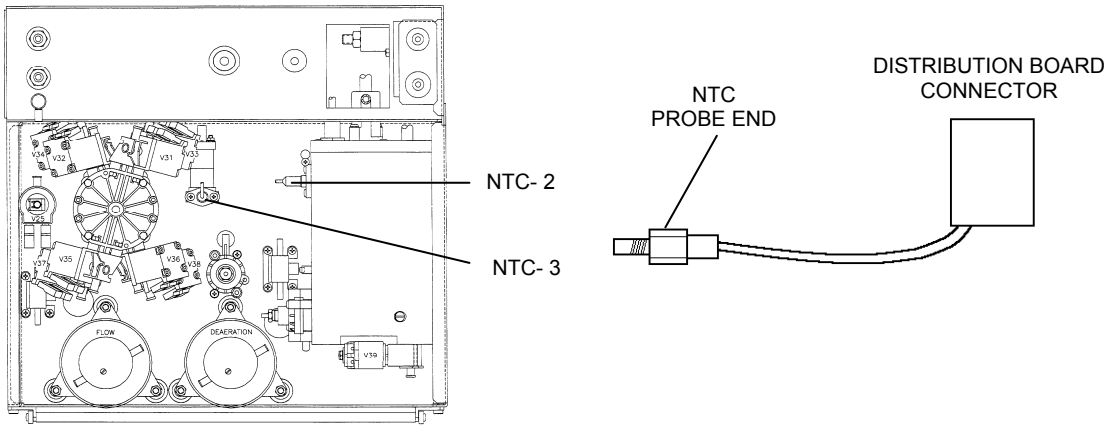


Figure 30 – Hydraulics (Rear View)

b) Unplug the NTC from its distribution board connector (see Figure 31 below). Using a flashlight, check inside the distribution board, for bent, broken, or corroded **male** pins.

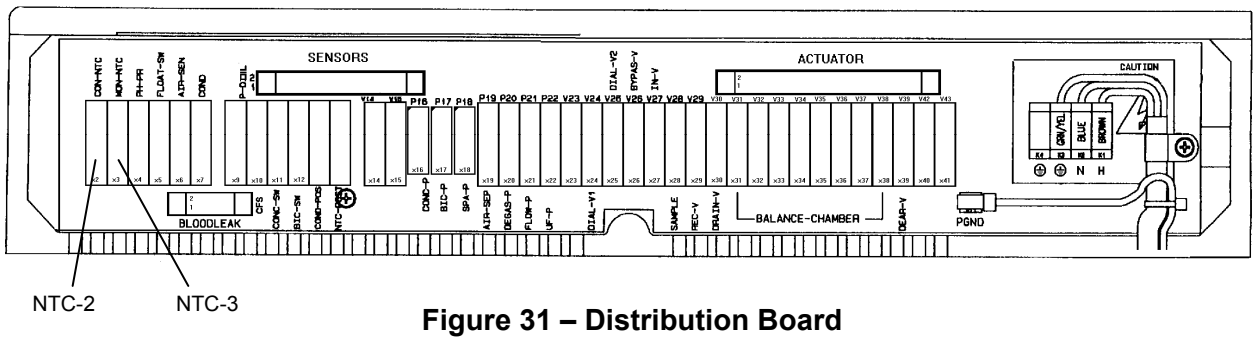


Figure 31 – Distribution Board

c) If no corrosion, remove the plastic cover from the NTC's female connector. Clip meter leads onto pins 1 and 3 (top and middle, typically green and white wires attached). Set the meter to RESISTANCE (Ω).

d) Fill a Styrofoam cup with water between 36°C and 38°C. Water temperature should be ACCURATELY measured with an **external** thermometer.

e) Drop the NTC 'probe' end into the water and allow 20 seconds for stabilization. Refer to Table 10 (next page).

- Replace any NTC that checks bad and calibrate HEATER TEMP CONTROL.
- If NTC(s) check good there are four possibilities: 1) *Bad sensor board cable; 2) HEATER TEMP CONTROL not calibrated accurately; 3) Bad sensor board; 4) Bad function board.

*The sensor cable can be checked for continuity. Note that you are checking **NTC-2** and/or **NTC-3** connections and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

Table 10 – NTC Resistance

Temperature (°C)	Low Resistance (KΩ)	Nominal Resistance (KΩ)	High Resistance (KΩ)
36.0	6.142	6.267	6.392
36.1	6.117	6.242	6.367
36.2	6.092	6.217	6.342
36.3	6.067	6.192	6.317
36.4	6.042	6.167	6.292
36.5	6.017	6.142	6.267
36.6	5.992	6.117	6.242
36.7	5.967	6.092	6.217
36.8	5.942	6.067	6.192
36.9	5.917	6.042	6.167
37.0	5.892	6.017	6.142
37.1	5.868	5.993	6.118
37.2	5.844	5.969	6.094
37.3	5.820	5.945	6.070
37.4	5.796	5.921	6.046
37.5	5.772	5.897	6.022
37.6	5.748	5.873	5.998
37.7	5.724	5.849	5.974
37.8	5.700	5.825	5.950
37.9	5.676	5.801	5.926
38.0	5.652	5.777	5.902

SECTION 5 - CONDUCTIVITY PROBLEMS

CO- 1.0.0 CHECK CONCENTRATE

a) If other machines are experiencing the same symptoms there may be a problem with the concentrate batch. Use fresh bicarb.

b) From the VERIFY CONCENTRATE screen assure that the proper concentrate, Na and Bic levels are selected.

c) Assure that the concentrate connectors are plugged into the proper concentrates. If all is ok proceed to CO- 1.0.1.

CO- 1.0.1 CHECK FLOW/TEMPERATURE

a) Call up debug screen 0. If FLOW ERROR = "1" a flow error is present. Do NOT troubleshoot CONDUCTIVITY PROBLEMS until flow errors are clear.

b) Push the CONFIRM key to return to the main screen. Assure TEMP is stable and within (+/-) 0.3 of unit standards. Do NOT troubleshoot CONDUCTIVITY PROBLEMS unless temperature is good.

c) If there are no flow errors or temperature problems proceed to CO- 1.0.2

CO- 1.0.2 CHECK FOR END OF STROKE (EOS) ERRORS

Call up debug screen 1. Is either NO EOS or ALWEOS ="1"?

Yes See SECTION 6 - CONCENTRATE PUMP END OF STROKE ERRORS (page 61).

No Proceed accordingly:

1) COND constantly low. See CO- 3.0.0
2) COND constantly high. See CO- 2.0.0
3) COND drifting from good to high. See CO- 2.0.0
4) COND rapidly bouncing from 10 to 17. See CO- 4.0.0 (page 57).

CO- 2.0.0 CHECK THE 'OUT OF BYPASS' HYDRAULIC CIRCUIT

Place the machine into RINSE and assure that the external flow indicator (75) is vertical. Is the' bob' (inside the indicator) rising?

Yes See CO- 7.0.0 (page 59)

No A flow problem is indicated. See F- 14.0.0 (page 18).

CO- 3.0.0 CHECK CONCENTRATE SELECTION

From the VERIFY CONCENTRATE screen is Bicarb or Acetate concentrate selected?

Bicarb See CO- 3.0.1

Acetate See CO- 3.0.2

CO- 3.0.1 CHECK BICARB STEPS

Call up debug screen 0. Is ABIC = "0"? IMPORTANT NOTE: If BIC also = "0" bicarb is NOT selected.

Yes See CO- 8.0.0 (page 60).

No See CO- 3.0.2

CO- 3.0.2 CHECK CONCENTRATE INLET

THIS IS AN IMPORTANT STEP! Looking through the acid and bicarb inlet lines (see Figure 32 below) is AIR FREE concentrate being pulled steadily, in one direction only?

Yes See CO- 5.0.0 (page 58).

No See CO- 3.0.3.

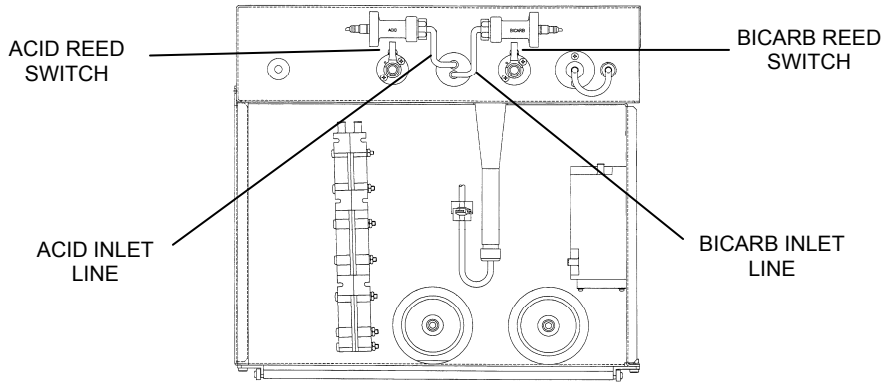


Figure 32 – Hydraulics (Front View)

CO- 3.0.3 CHECK CONCENTRATE CONNECTOR

a) Check the concentrate connector filter and o-ring #3 (see Figure 33 below).

b) Place the machine into RINSE mode. Is either concentrate connector leaking?

Yes See CO- 3.0.4.

No Allow the machine to run in RINSE for a few minutes (to remove a possible air lock) and return to DIALYZE mode. If the pump still does not draw see CO- 3.0.4.

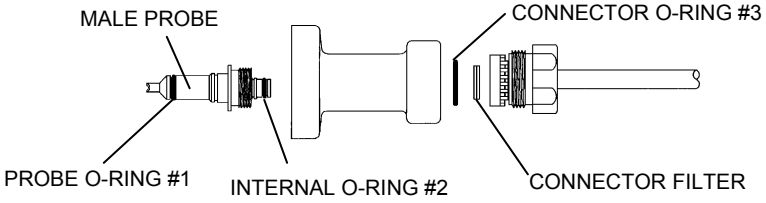


Figure 33 – Concentrate Connector

CO- 3.0.4 CHECK CONNECTOR 0-RINGS

a) Check male probe o-rings #1 and #2 (see Figure 33 on previous page).

b) If the pump still does not draw, place the entire concentrate connector into water. Does the pump draw now?

Yes The wand is bad (see Figure 34 below).

No Check the concentrate pump for broken springs, bad seals, bad o-rings, bad diaphragm (see Figure 34 below).

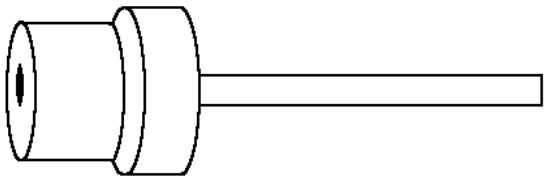


Figure 34 – Wand

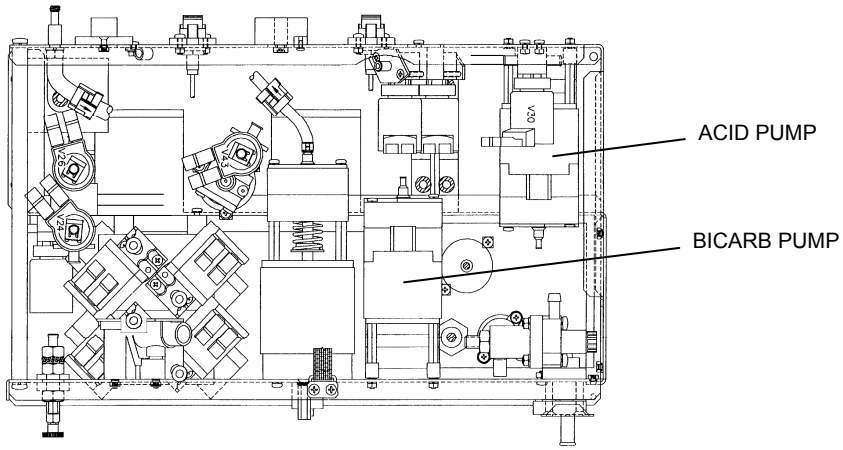


Figure 35 – Hydraulics (Top View)

CO- 4.0.0 CHECK FOR AIR AT CONDUCTIVITY CELL

Check the clear tubing at both sides of the conductivity cell (see Figure 36 on next page). Is there excessive air flowing through it?

Yes a) Plug the bicarb connector back into it's port and wait for a few minutes. Check for air again at the cell. If air is not seen a problem is indicated in the bicarb injection system. Check first the bicarbonate connector for bad o-rings.

b) Calibrate DEAERATION PRESSURE by first decreasing the DAC value until pressure is below -18 inHg and then increasing it SLOWLY to -24 inHg.

c) Perform SECTION 11 - NEGATIVE PRESSURE TESTS (page 77) and SECTION 12 - INDUCED POSITIVE PRESSURE TESTS (page 80). Look for fluid leaks especially at balancing chamber valves 31 and 33.

No See CO- 4.0.1

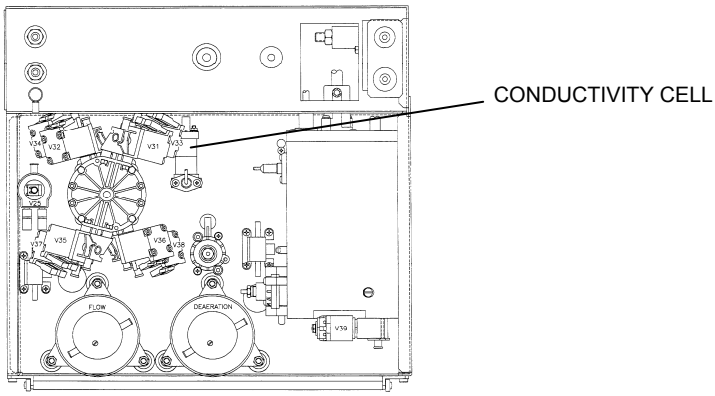


Figure 36 – Hydraulics (Rear View)

CO- 4.0.1 CHECK DEBUG CELL VALUES

Assure that the machine has run for 10 minutes with fresh concentrate connected and call up debug screen 5 (frequency values in Hertz). Is FPRE between 1392 and 3072 Hertz or is it 'bouncing' to greater than 8000 Hertz?

Between	See CO- 6.0.0.
Bouncing	Two possibilities; 1) Bad sensor board; 2) Bad actuator board.

CO- 5.0.0 CHECK DEBUG CELL VALUES

Assure that the machine has run for 10 minutes with fresh concentrate connected and call up debug screen 5 (frequency values in Hertz). Is FPRE between 1392 and 3072 Hertz?

Yes	See CO- 6.0.0.
No	See CO- 5.0.1

CO- 5.0.1 PERFORM PRESSURE TEST

a) Select a flow rate of 500 ml/min, clear blood alarms, and turn on the blood pump.

b) Select a UF RATE of 1000 ml/hr and turn UF on (green UF on/off LED MUST be on solid and the UF RATE numeric display must NOT blink).

c) Allow TMP increase to about 260 and then turn UF off. Allow 30 seconds for stabilization.

d) After stabilization does TMP remain stable (within +/- 60 mmHg) for three minutes?

Yes	Check BALANCING CHAMBER VOLUME and calibrate *ACID and *BICARB PUMP VOLUMES and CONDUCTIVITY CELL per CALIBRATION PROCEDURES.
No	See SECTION 10 - PRESSURE HOLDING TESTS FAILING (page 72).

* While the pumps are drawing concentrate from the burette determine if each is taking CONSTANT volumes per stroke (in one direction ONLY). If not check the pump's springs, seals, and diaphragm.

CO- 6.0.0 CHECK CONDUCTIVITY CELL

a) Turn flow off and note the FPRE value.

b) Unplug the float from the distribution board (x5, FLOAT-SW) and plug it into the conductivity cell's position (x7, COND).

c) From debug screen 5 does the FPRE value go very high?

Yes Two possibilities: 1) Concentrate is bad or not being pulled by the concentrate pumps; 2) Bad conductivity cell (see Figure 36 on previous page).

No Remains at previous value. Two possibilities: 1) *Bad sensor board cable; 2) Bad distribution board connection (check carefully for corrosion).

* The sensor cable can be checked for continuity. Note that you are checking the COND CELL connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

CO- 7.0.0 CHECK DEBUG CONDUCTIVITY VALUE

Go to RINSE and call up debug screen 5. After 5 minutes does FPRE= 4000 or less?

Yes See CO- 7.0.1

No See CO- 7.0.3

CO- 7.0.1 PERFORM PRESSURE TEST

a) Place the machine into DIALYZE MODE. Select a flow rate of 500 ml/min, clear blood alarms and turn the blood pump rate knob clockwise.

b) Select a UF RATE of 1000 ml/hr and turn UF on (green UF on/off LED MUST be on solid and the UF RATE numeric display must NOT blink).

c) Allow TMP increase to about 260 and then turn UF off. Allow 30 seconds for stabilization.

d) After stabilization does TMP remain stable (within +/- 60 mmHg) for three minutes?

Yes See CO- 7.0.2

No See SECTION 10 - PRESSURE HOLDING TESTS FAILING (page 72).

CO- 7.0.2 CHECK FOR INTERMITTENT FLOW ERROR

Call up debug screen 0 and watch FLOW ERROR very carefully for 10 minutes. Does FLOW ERROR ever go to "1" during this time interval?

Yes An intermittent flow error is indicated. See F- 9.0.0 (page 13).

No Check BALANCING CHAMBER VOLUME and calibrate *ACID and *BICARB PUMP VOLUMES and CONDUCTIVITY CELL per CALIBRATION PROCEDURES.

* While the pumps are drawing concentrate from the buret determine if each is taking CONSTANT volumes per stroke (in one direction ONLY). If not check the pump's springs, seals, and diaphragm.

CO- 7.0.3 CHECK FOR 'SHORTED' CONDUCTIVITY CELL

a) Unplug the conductivity cell from the distribution board (position x7, COND). Check, inside the distribution board, for bent or corroded male pins.

b) Plug the 34°C Fresenius test (temperature) dummy connector into the cell's position (x7, COND). From debug screen 5, FPRE =3000 or less?

Yes Replace the conductivity cell (see Figure 36, page 58).

No See CO- 7.0.4.

CO- 7.0.4 CHECK SENSOR BOARD CABLE

a) Turn the power off and unplug both ends of the 34-pin sensor board cable. The sensor board is the smallest board in the card cage (far right). The cable plugs into the top edge and runs into the distribution board.

b) Check for bent or corroded male pins at the sensor and distribution board connectors.

c) Leave the cable unplugged for now and turn the power on. From the SELECT PROGRAM screen push the CONFIRM key ONCE and then call up debug screen 5. Is ACON= 3000 or less?

Yes The sensor board cable is bad.

No Two possibilities: 1) Bad sensor board; 2) Bad distribution board

CO- 8.0.0 CHECK BICARB DEBUG SIGNAL

The machine 'thinks' that the blue bicarb connector is plugged into it's port.

Call up debug screen 2. With the bicarb connector out of it's port does BICOUT = "1"

Yes Two possibilities; 1) Bad actuator board; 2) Bad functional board.

No See CO- 8.0.1.

CO- 8.0.1 CHECK THE BICARB REED SWITCH

Unplug the bicarb reed switch from distribution board position x12, BIC-SW. Is BICOUT "1" now?

Yes Replace the bicarb reed switch (see Figure 32 on page 56).

No
a) Check inside the distribution board for bent or corroded male pins.
b) Unplug the sensor cable from both ends and check the female and male connectors for corrosion.
c) Plug all cables back in and place the machine into dialyze mode. If the problem is still present there are two possibilities; 1) Bad actuator board; 2) Bad functional board.

SECTION 6 - CONCENTRATE PUMP 'END OF STROKE' (EOS) ERRORS

EOS- 1.0.0 DETERMINE THE EOS

Call up debug screen 0:

If the CONC symbol

is solid pink, the ACID pump is issuing an EOS error. See EOS- 2.0.0

If the BIC symbol

is solid pink, the BICARB pump is issuing an EOS error. See EOS- 3.0.0

EOS- 2.0.0 CHECK ACID PUMP

This procedure uses the bicarb pump (known good) to check the acid pump.

a) Switch the concentrate pump connectors at the distribution board (i.e. Turn the machine OFF then plug the bicarb pump into acid pump's position and visa-versa, see Figure 37 below).

b) Call up debug screen 0 and wait at least 1 minute. Is the CONC symbol solid pink or clear?

Pink See EOS- 4.0.0

Clear Replace the acid pump (or see 2008K ACID & BICARBONATE REPAIR PROCEDURE).

EOS- 3.0.0 CHECK BICARB PUMP

This procedure uses the acid pump (known good) to check the bicarb pump.

a) Switch the concentrate pump connectors at the distribution board (i.e. Turn the machine OFF then plug the acid pump into bicarb pump's position and visa-versa, see Figure 37 below).

b) Call up debug screen 0 and wait at least 1 minute. Is the BIC symbol solid pink or clear?

Pink See EOS- 4.0.0

Clear Replace the bicarb pump (or see 2008K ACID & BICARBONATE REPAIR PROCEDURE).

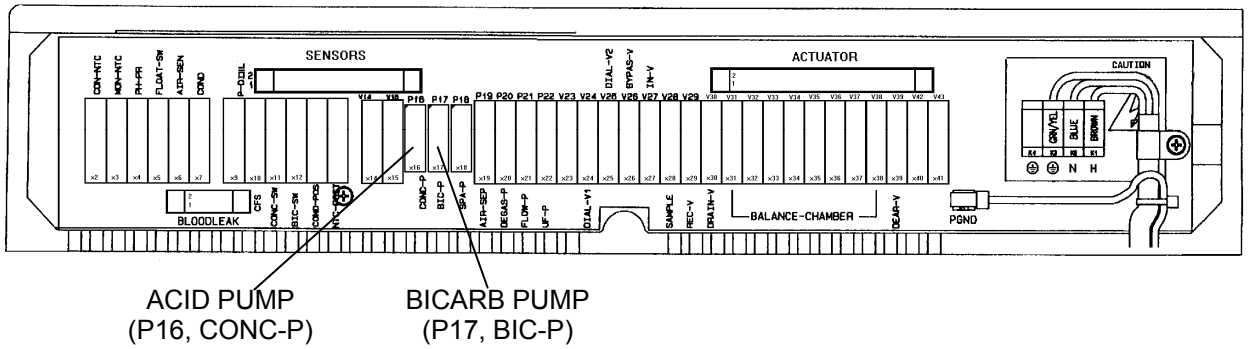


Figure 37 – Distribution Board

EOS- 4.0.0 CHECK CONCENTRATE PUMP CIRCUIT

Four possibilities: 1) [a]Bad actuator cable; 2) [b]Bad sensor board cable; 3) Bad actuator board; 4) Bad distribution board (check for corrosion).

[a] The actuator cable can be checked. Which 'side' is issuing the error?

ACID	The actuator cable can be checked for continuity. Note that you are checking ACID PUMP connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).
BICARB	The actuator cable can be checked for continuity. Note that you are checking BICARB PUMP connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

[b] The sensor cable can be checked. Which 'side' is issuing the error?

ACID	The sensor cable can be checked for continuity. Note that you are checking the ACID EOS connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).
BICARB	The sensor cable can be checked for continuity. Note that you are checking the BICARB EOS connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

SECTION 7 - COND OFFSET REF OR COND OFFSET FAILURES

Perform these procedures ONLY if the machine is issuing "COND OFFSET REF" or "COND OFFSET FAILURE" messages upon power up.

NOTE: If you have changed the SENSOR or FUNCTIONAL board since the last COND CELL CALIBRATION these failures are normal. Perform COND CELL CALIBRATIONS.

CR- 1.0.0 TROUBLESHOOTING OFFSET ERRORS

Attempt to calibrate CONDUCTIVITY CELL per CALIBRATION PROCEDURES. If unsuccessful there are four possibilities: 1) *Bad test board; 2) Bad sensor board; 3) Bad actuator board; 4) Bad functional board.

* NOTE: An alternative to swapping the test board is to remove IC 30 from the test board and run the machine without it. The machine runs ok without IC 30 but will fail tests.

SECTION 8 - FILLING PROGRAM PROBLEMS

FIL- 1.0.0 CHECK FOR FLOW ERROR

a) Assure that the vent tubing (back of machine) is not 'pinched' (see Figure 6, page 5).

b) Assure the dialysate lines are in the shunt and the door is closed.

c) Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch for two minutes or until you see either a NO WATER alarm or a flow error (FLOW ERROR = "1"). Proceed accordingly:

- NO WATER ALARM (intermittent or constant). See SECTION 2 - NO WATER (page 24).
- FLOW ERROR = "1" (intermittently or constant). See FIL- 1.0.1.
- FLOW ERROR = "0" (constant). See FIL- 2.0.0

FIL- 1.0.1 CHECK FILACT

Call debug screen 1. Is FILACT = "1"?

Yes See FIL- 1.0.2

No Proceed to SECTION 1 - FLOW ERRORS IN DIALYZE MODE (page 6)

FIL- 1.0.2 CHECK FLOW PUMP

a) The flow pump's motor shaft can be viewed from the front of the hydraulics (see Figure 38 below). When a FILLING PROGRAM is active, the motor rotates intermittently.

b) Watch the motor shaft for 20 seconds. Is it rotating counter-clockwise (viewed from the FRONT)

Yes See FIL- 1.0.3

No See TROUBLESHOOTING MOTORS (page 23) to check the FLOW PUMP.

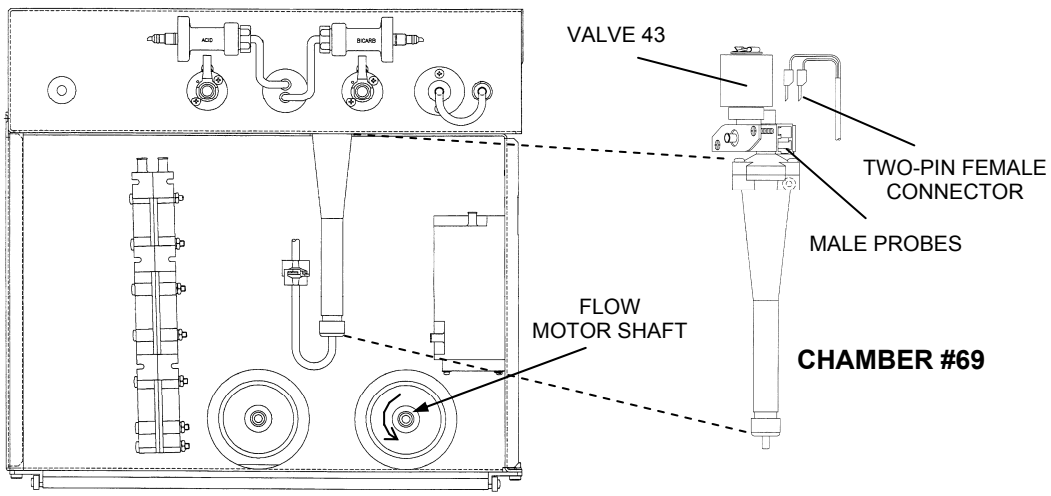


Figure 38 – Hydraulics (Front View)

FIL- 1.0.3 CHECK FLOW PUMP CONTROL

Is the flow motor running intermittently?

Yes See FIL- 1.0.4.

No Replace the actuator board (shorted driver).

FIL- 1.0.4 CHECK FILLING PROGRAM FUNCTION

On top of chamber #69 (see Figure 38 on previous page) is a two-pin female connector that plugs into two male probes. Both probes extend into the chamber.

a) Unplug both sides of the connector from chamber #69 and connect the female ends together (to simulate no air).

CAUTION! Do NOT unplug the two-wire harness to valve #43 (see Figure 38 on previous page).

b) Wait 30 seconds. Does FILACT = "0"?

Yes See FIL- 1.0.5

No See FIL- 4.0.0

FIL- 1.0.5 CHECK FOR FLOW ERROR W/O FILLING PROGRAM

a) Wait 30 seconds longer

b) Call debug screen 0. Intermittent flow errors are easily missed with a 'quick look' so watch FLOW ERROR for two minutes. Proceed accordingly:

FLOW ERROR = "0" (constant).	See FIL- 5.0.0 (page 68)
FLOW ERROR = "1".	Leave the female ends connected together and proceed to SECTION 1 – FLOW ERRORS IN DIALYZE MODE (page 6).

FIL- 2.0.0 CHECK CONDUCTIVITY

Push the blue HOME screen button to return to the main screen. Is Conductivity greater than 10 mS/cm?

Yes Do NOT continue troubleshooting FILLING PROGRAM PROBLEMS when Conductivity is less than 10 mS/cm.

No See FIL- 2.0.1.

FIL- 2.0.1 CHECK FILACT

Call debug screen 1. Is FILACT = "1"?

Yes See FIL- 3.0.0.

No See FIL- 2.0.2.

FIL- 2.0.2 FILLING PROGRAM CHECKS

Filling programs are caused by air leaks into the secondary-side hydraulic circuit. If you are seeing "10 FILL PROGRAMS IN 1 HR":

a) Check the external acid and bicarbonate concentrate inlet lines for air.

b) Check deaeration pressure (- 24 inHg).

c) Perform SECTION 11 - NEGATIVE PRESSURE TESTS (page 77) to look for air leaks.

d) Perform SECTION 12 - INDUCED POSITIVE PRESSURE TESTS (page 80) to look for fluid leaks.

FIL- 3.0.0 CHECK AIR SENSOR

On top of chamber #69 (see Figure 38 on page 64) is a two-pin female connector that plugs into two male probes. Both probes extend into the chamber.

a) Assure that both ends of two-pin female connector are plugged into **male** probes with the brown wire on the top.

b) Unplug both sides of the connector from chamber #69 and connect the female ends together (to simulate no air).

CAUTION! Do NOT unplug the two-wire harness to valve #43 (see Figure 38 on page 64).

c) Wait 30 seconds. Does FILACT = "0"?

Yes See FIL- 3.0.1.

No See FIL- 4.0.0.

FIL- 3.0.1 CHECK CONNECTOR

a) Plug the both ends of the female connector back onto the male probes (brown wire on top). Make VERY sure of good connections!

b) Wait 30 seconds. Does FILACT = "0"?

Yes Check the two-pin female wiring harness for exposed wires otherwise the problem is no longer present.

No See FIL- 4.0.1.

FIL- 4.0.0 CHECK DISTRIBUTION BOARD

a) Plug the both ends of the female connector back onto the male probes (brown wire on top probe). **IMPORTANT**! Make VERY sure of good connections!

b) From the female connector trace the wiring harness back into the distribution board and assure that it terminates at position x6, AIR-SEN. If not this is the problem!

c) Unplug the air sensor connector from distribution board position x6, AIR-SEN. Using a flashlight, check inside the distribution board for 'white' corrosion (indicative of spillage).

d) If corrosion not present: inside the distribution board there should be five male pins. Check for bent or broken male pins.

e) If all pins are okay: place a jumper wire, inside the distribution board, BETWEEN male pins 1 and 5 (top and bottom). **CAUTION**! Make VERY sure that you put the jumper into the correct distribution board position (x6, AIR-SEN). **IMPORTANT**! Make VERY sure of a good jumper connection!

f) Wait 30 seconds. FILACT = "0"?

Yes The two-pin female connector is bad (open).

No See FIL- 4.0.1.

FIL- 4.0.1 CHECK SENSOR BOARD

a) Plug the connector back into the distribution board position x6, AIR-SEN. **CAUTION!** Be careful to plug in correctly.

b) To avoid calibration reference errors go into Service Mode and select YES for T and C (Test and Calibration) Mode on the Hardware Options screen. Remember to press the CONFIRM key to activate the change. When troubleshooting is complete, go back into Service Mode and select NO for T and C Mode.

c) Swap in a new sensor board and return to DIALYSIS PROGRAM.

d) Wait until temperature and conductivity is normal (about eight minutes).

e) Call debug screen 1. FILACT = "1"?

Yes Two possibilities: 1) *Bad sensor board cable; 2) Bad function board. The previous sensor board is good.

No The previous sensor board is bad.

* The sensor cable can be checked for continuity. Note that you are checking the **AIR SENSOR** connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

FIL- 5.0.0 CHECK FOR VALVE ERRORS (VERR)

a) Valve errors are caused by electrical current problems in the valve circuits. If a valve error is present VERR will increase to a maximum of 255. If a valve error is not present VERR will remain 0.

b) During these procedures you will place the machine into a RINSE program and watch for a valve error (VERR). In RINSE debug is called by pushing the DOWN ARROW key ONLY. You need to enter debug and then call screen 1 (push the UP ARROW key) as quickly as you can. VERR is in the lower right hand corner.

c) You will also be asked to call and watch screen 0's valve #43. When a valve is energized the circle, next to the valve, turns solid blue.

d) Proceed to FIL- 5.0.1

FIL- 5.0.1 CHECK FOR A VALVE ERROR AT VALVE #43

a) **IMPORTANT** turn the power off and then back on.

b) Place the concentrate connectors back into their ports and place the machine into RINSE program

c) QUICKLY enter debug screen 0 and watch V43. When it energizes call screen 1. Is VERR increasing?

Yes **NOTE** that you are in RINSE program and there is a valve error at VALVE #43. Proceed to TROUBLESHOOTING VALVE ERRORS (page 31).

No See FIL- 5.0.2.

FIL- 5.0.2 CHECK VALVE #43

a) Clamp and remove the output tubing from valve #43 (see Figure 38 on page 64).

b) From debug screen 0, when V43 is energized (circle solid blue) is there strong 'pulsing' flow from the nozzle?

Yes See FIL- 5.0.3.

No A problem is indicated with the actuator board or VALVE #43. **NOTE** this and see TROUBLESHOOTING VALVES (page 30).

FIL- 5.0.3 CHECK FLOW ERROR

Everything in the FILLING CIRCUIT seems to be functioning properly!

a) Pull the RED and BLUE concentrate connectors and plug them into concentrate.

b) Reconnect the tubing to valve #43.

c) Place the machine into DIALYSIS program and call debug screen 1.

d) Allow 30 seconds. If FILACT = "0" unplug the air sensor connector from distribution board position x6, AIR-SEN. FILACT should now = "1" (after 30 seconds).

e) Call debug screen 0 and watch FLOW ERROR for two minutes. If a flow error returns i.e. FLOW ERROR = "1" (either intermittent or constant) replace the *dialysate pressure transducer #9 (see Figure 6, page 5).

* The dialysate pressure transducer #9 senses flow in FILLING PROGRAMS.

SECTION 9 - TMP PROBLEMS

TMP- 1.0.0 CHECK FOR A FLOW ERROR

a) Assure that dialysate flow is on (flow on/off LED off).

b) Call debug screen 0. Intermittent problems are easily missed with a 'quick look' so watch FLOW ERROR for two minutes or until you see FLOW ERROR = "1". Proceed accordingly:

FLOW ERROR = "0" (constant):	See TMP- 1.0.1
FLOW ERROR = "1" (intermittent or constant):	Do **NOT** continue troubleshooting TMP PROBLEMS when a flow error is present.

TMP- 1.0.1 CHECK FOR A FILLING PROGRAM (FILACT)

Call debug screen 1. Is FILACT = "1"?

Yes Do **NOT** continue troubleshooting TMP PROBLEMS when a filling program is present.

No See TMP- 1.0.2.

TMP- 1.0.2 CHECK TMP FAULT

Push the blue HOME screen button to return to the main screen. Is the TMP bar graph display (below the digital display) stuck at either below 0 or higher than 500 mmHg?

Yes See TMP- 1.0.3

No Stop! A TMP problem is not indicated. Perform machine tests.

TMP- 1.0.3 ADJUST TMP

a) Push RESET. The message "ADJUST TMP?" comes up on the screen.

b) Push and hold RESET until "ADJUST TMP" is up. Does TMP move from its previous value?

Yes See TMP- 1.0.4.

No See TMP- 2.0.0.

TMP- 1.0.4 CHECK FOR TMP STUCK HIGH OR LOW

Does TMP return quickly (within 20 seconds) to its previous 'pegged' value?

Yes Proceed to SECTION 10 – PRESSURE HOLDING TESTS FAILING (page 72).

No Stop! A TMP problem is not indicated. Perform machine tests.

TMP- 2.0.0 CHECK TEST BOARD

a) Turn the power off and swap in a known good test board. **NOTE** An alternative is to remove IC 4 from the test board. The machine runs fine without IC 4 but will fail tests.

b) Turn the power on and enter DIALYSIS program. If necessary RESET and try to ADJUST TMP (as above). Does TMP move from its previous value?

Yes The previous test board (or IC 4) is bad.

No See TMP- 3.0.0 (the previous test board is good).

TMP- 3.0.0 CHECK SENSOR BOARD DEBUG VALUE (PDIA)

Call debug screen 4. Look at PDIA (in volts)

PDIA = 0 to 2 volts See TMP- 4.0.0.

PDIA = 2 to 7 volts Calibrate DIALYSATE PRESSURE per CALIBRATION PROCEDURES. If unsuccessful replace the dialysate pressure transducer (see Figure 6, page 5).

PDIA = 7 to 12 volts See TMP- 5.0.0.

TMP- 4.0.0 CHECK DIALYSATE PRESSURE TRANSDUCER

a) Unplug the dialysate pressure transducer from distribution board position x9, P-DIAL. Using a flashlight check, inside the distribution board, for corrosion.

b) If no corrosion: does PDIA = 7 to 10 volts?

Yes Replace the dialysate pressure transducer (see Figure 6, page 5) and calibrate DIALYSATE PRESSURE per CALIBRATION PROCEDURES.

No See TMP- 6.0.0.

TMP- 5.0.0 CHECK DIALYSATE PRESSURE TRANSDUCER

a) Unplug the dialysate pressure transducer from distribution board position x9, P-DIAL. Using a flashlight check, inside the distribution board, for corrosion (indicative of spillage).

b) If no corrosion: inside the distribution board there should be five **male** pins. Check for bent or broken **male** pins.

c) If all pins are okay: plug the 34 degree temperature 'dummy connector' into the transducer's distribution board position. Is PDIA = 0 volts?

Yes Replace the dialysate pressure transducer (see Figure 6, page 5) and calibrate DIALYSATE PRESSURE per CALIBRATION PROCEDURES.

No See TMP- 6.0.0

TMP- 6.0.0 CHECK DIALYSATE PRESSURE CIRCUIT

a) IMPORTANT plug the transducer back into the distribution board position x9, P-DIAL.

b) Five possibilities: 1) *Bad sensor board cable; 2) Bad sensor board; 3) Bad actuator board; 4) Bad function board; 5) Bad distribution board.

* The sensor cable can be checked for continuity. Note that you are checking **DIALYSATE TRANSDUCER** connections and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

SECTION 10 - PRESSURE HOLDING TESTS FAILING

PHT- 1.0.0 CHECK UF PUMP CIRCUIT

From dialysis program, with dialysate flow on, call debug screen 0. Is the UF pump symbol solid pink or clear?

Pink Indicates an open UF pump circuit. Four possibilities: 1) [1]Bad actuator board cable; 2) Bad actuator board; 3) [2]Bad UF pump solenoid; 4) Bad distribution board.

Clear See PHT- 2.0.0

[1] The actuator cable can be checked for continuity. Note that you are checking **UF PUMP** connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

[2] The UF pump solenoid can be checked. Unplug its female connector from the distribution board (position P22-UF-P), remove the plastic cover, and measure resistance BETWEEN the two soldered wires inside the female connector. A good solenoid will be measure between 8 and 12 Ω.

PHT- 2.0.0 CHECK FOR LEAKS

a) Check for obvious external fluid leaks in the hydraulic compartment and at dialyzer quick connectors, external flow indicator and red dialysate line filter.

b) Check the clear acid and bicarbonate concentrate inlet lines for air.

c) Remove the tubing from the FLUID SAMPLE port. If fluid is coming from the port check valve #64 (see Figure 39 on page 73) is bad.

d) If no leaks see PHT- 3.0.0

PHT- 3.0.0 CHECK DEAERATION PRESSURE

a) Turn dialysate flow off (flow on/off LED on) and wait **60 seconds** or until you hear the deaeration motor turn off.

b) Tee a negative pressure gauge between the clear (INPUT) line and the deaeration pump's input nozzle (see Figure 17 on page 28). **NOTE** If the gauge does not read 0 inHg when not connected compensate your reading.

c) Turn dialysate flow on (flow on/off LED off). Is deaeration pressure between –22 and -26 inHg?

Yes See PHT- 4.0.0

No See SECTION 13 - DEAERATION PROBLEMS (page 81).

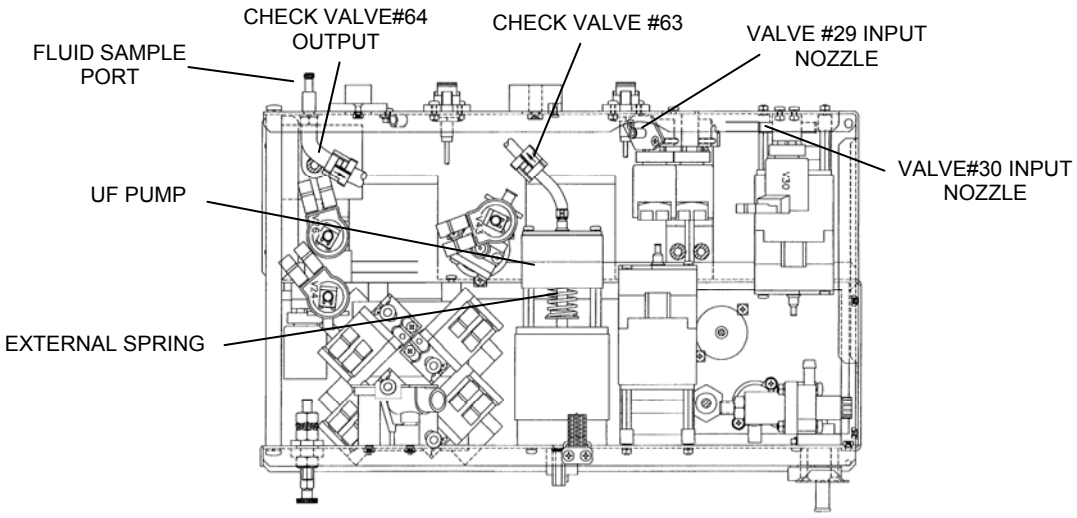


Figure 39 – Hydraulics (Top View)

PHT- 4.0.0 CHECK UF PUMP STROKING

During this procedure you will determine if the UF pump is 'stroking' i.e. back and forth compressions of the large external spring (see Figure 39 above).

a) Turn dialysate flow off (flow on/off LED on).

b) Remove the dialysate lines from the shunt door and drop them into a bucket of water at dialyzer height. The dialyzer quick connectors must be fully submersed.

c) Reset ALL blood alarms and set blood pump rate to 200 ml/min or greater and assure that the blood pump door is closed.

d) From the main screen set UF RATE to between 1000 and 2000 ml/hr and push the CONFIRM key.

e) Push the UF on/off key to turn *UF on. Does the UF pump stroke?

Yes See PHT- 5.0.0

No Two possibilities: 1) Bad actuator board. 2) Bad UF pump.

* When UF is on: 1) The green UF on/off LED turns on solid (does not blink); 2) The UF RATE numeric display does not blink; 3) The UF REMOVED numeric display increases.

NOTE: FILLING PROGRAMS and BLOOD ALARMS turns UF off! To clear a FILLING PROGRAM, turn dialysate flow on until it clears and then turn flow off again. BLOOD ALARMS are cleared with the RESET key. Push the key twice and hold it in the second time.

PHT- 5.0.0 CHECK UF PUMP OUTPUT

Assure that UF is on (UF REMOVED increasing). Are there 'strong pulses' from the tubing?

Yes See PHT- 6.0.0.

No Assure that *check valve #63 is good. If good, see REBUILDING THE ULTRAFILTRATION PUMP per PREVENTATIVE MAINTENANCE PROCEDURES.

* Check valve #63 (15 lbs) is located directly at the output port of the UF pump (see Figure 39 on page 73). If oriented backwards or if its bad it will prevent UF output.

PHT- 6.0.0 CHECK UF PUMP VOLUME

Collect 24 strokes UF pump output, from the fluid sample tube, into a 25ml buret. 24 strokes should yield 24ml ± 1ml (0.1 ml/stroke). Is UF volume okay?

Yes See PHT- 7.0.0.

No Check for leaks at the UF pump. If no leaks, calibrate UF PUMP VOLUME per CALIBRATION PROCEDURES.

PHT- 7.0.0 CHECK TMP PUMP UP

a) Turn UF off and connect the fluid sample tube back onto the machine.

b) Place the dialysate lines back into the shunt door and close the door.

c) Reset all blood alarms and turn UF on (assure UF REMOVED is increasing). If a FILLING PROGRAM occurs clear any blood alarms and start over. Does TMP increase to 260 mmHg or greater?

Yes See PHT- 7.0.1.

No See PHT- 8.0.0.

PHT- 7.0.1 CHECK PRESSURE HOLDING

a) Turn UF off and allow 20 seconds for TMP to stabilize. If necessary reset the alarm limits. If TMP rises beyond 500 mmHg, start over.

b) Watch TMP for three minutes. Does it remain within +/- 60 mmHg from where it stabilized?

Yes See PHT- 7.0.2

No Perform SECTION 12 - INDUCED POSITIVE PRESSURE TEST (page 80). If no leaks are found see PHT- 9.0.0

PHT- 7.0.2 CHECK BALANCING CHAMBER VALVES

a) Turn dialysate flow on and allow 20 seconds for TMP to stabilize (if not 200 mmHg or greater turn UF on momentarily until it is and then turn UF off).

b) Watch TMP for three minutes. Does it remain within ±60 mmHg from where it stabilized?

Yes See PHT- 7.0.3.

No See PHT- 9.0.0.

PHT- 7.0.3 CHECK TMP CALIBRATION

a) Turn dialysate flow off and place the four-way connector in the dialysate lines. Connect one of the smaller tubings to an external pressure meter and clamp this line for now. Connect the other tubing to a syringe and clamp this line for now.

b) Turn dialysate flow on and allow Temperature and Conductivity to stabilize.

c) Reset blood alarms and turn dialysate flow off.

d) Unclamp all lines and draw on the syringe until the meter reads about –200 mmHg.

e) From the main screen is TMP within +/- 40 mmHg of the meter's reading?

Yes See PHT- 9.0.0

No Calibrate DIALYSATE PRESSURE per procedure.

PHT- 8.0.0 CHECK 'CHECK VALVE' #64

a) Reset ALL blood alarms.

b) Remove *check valve #64's OUTPUT tubing (see Figure 39 on page 73) from the Y-connector.

* Check valve #64 (1 lbs) is located on the opposite side of the fluid sample port. If oriented backwards or if it's bad it will prevent UF output.

c) Turn UF on (assure UF REMOVED is increasing). Is there 1 ml 'pulses' through this check valve?

Yes Turn UF off, reconnect check valve #64 output tubing and see PHT- 9.0.0.

No Check valve #64 is bad.

PHT- 9.0.0 CHECK BALANCING CHAMBER VALVES AND BALANCING CHAMBER DIAPHRAGM

Perform SECTION 18 - MANUAL BALANCING CHAMBER VALVE LEAK TESTS (page 92) on the balancing chamber valves (V31 through V38). Did the leak test indicate a leaking valve?

Yes See PHT- 9.0.1.

No Possible leaking balancing chamber diaphragm. Perform SECTION 19 - TESTING FOR A LEAKING BALANCING CHAMBER DIAPHRAGM (page 96).

PHT- 9.0.1 CHECK FOR A SHORTED VALVE DRIVER

a) Unplug the indicated leaking valve from the distribution board (see Figure 40 below). Using a flashlight, check inside the distribution board, for 'white corrosion' (indicative of spillage).

b) If no corrosion: measure volts dc, inside the distribution board, BETWEEN **male** pins 1 and 5 (top and bottom). Place the red lead at pin 5 (bottom). Greater than one volt?

Yes Replace the actuator board (shorted driver).

No Replace the indicated leaking balancing chamber valve.

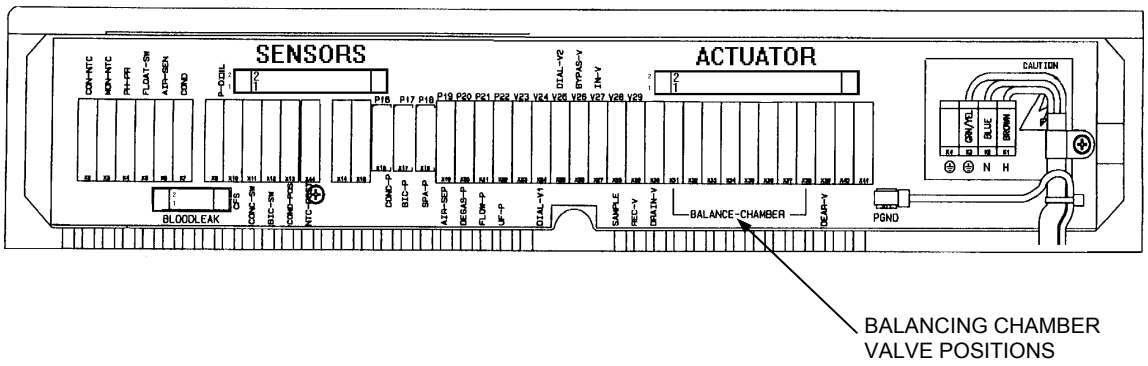


Figure 40 - Distribution Board

SECTION 11 - NEGATIVE PRESSURE TESTS

These tests use negative pressure to locate a hydraulic leak.

- It is assumed that deaeration pressure has been previously checked to between –22 and -26 inHg
- Using a flashlight is helpful. All checks are performed by looking through clear hydraulic tubing.

AIR- 1.0.0 CHECK FOR AIR LEAK

a) Assure that the dialysate lines are in the shunt and the door is closed.

b) Clear ALL dialysate and blood alarms and set blood pump rate to about 200 ml/min.

c) Set UF RATE of about 1000 ml/hr and turn UF on (green UF on/off LED **MUST** be on solid and the UF RATE numeric display **MUST NOT** blink).

d) Allow TMP to increase to about 260 mmHg and turn UF off.

NOTE: TMP should be maintained at 260 mmHg (or greater) to run these tests. Air bubbles are larger and easier to see at higher TMP.

e) Look through the clear tubing at the OUTPUT of the blood leak detector tubing (see Figure 41 below), are *large air bubbles seen?

Yes See AIR- 1.0.1

No An air leak is not obvious using this test. If referred to this step, return to the referring procedures and proceed accordingly.

* Smaller air bubbles may be 'normal'. Check another machine (that is passing pressure holding tests) to determine what 'normal' looks like.

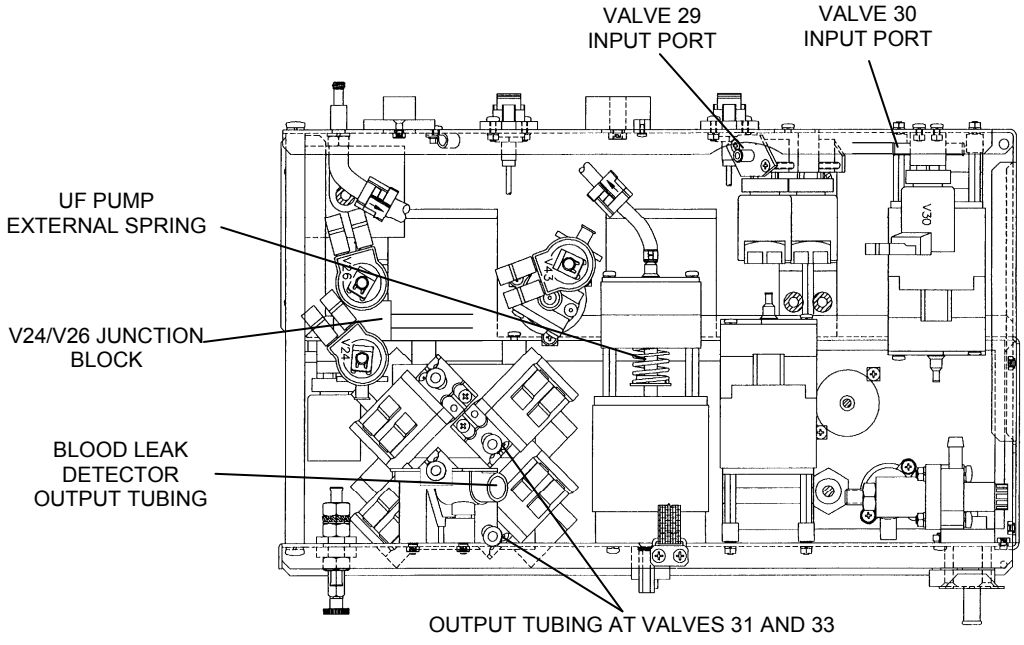


Figure 41 – Hydraulics (Top View)

AIR- 1.0.1 LOCATING THE LEAK

Check for air bubbles at the following locations in the following order:

IMPORTANT! TMP must be maintained at 260 or greater for these tests.

a) **OUTPUT** tubing at valve 25 (see Figure 42 below). If air is not seen check the tubing connections at the blood leak detector and dialysate pressure transducer.

b) **INPUT** tubing at the external dialysate line filter (#73) (see Figure 6, page 5). If air is not seen check the o-ring inside the filter housing.

c) **INPUT** tubing at the blue quick connector. If air is not seen replace the quick connector o-rings

d) **INPUT** tubing at the external flow indicator (#75) (see Figure 6, page 5). If air is not seen check the o-rings inside the indicator.

e) **INPUT** tubing at the valve 24/26 junction block (see Figure 41 on previous page). If air is not seen check the block for bad o-rings or cracks.

f) **OUTPUT** tubing from balancing chamber valves 31 and 33 (see Figure 42 below). If air is not seen check the tubing connections at the conductivity cell #7.

g) Is air coming from ONE or BOTH valves 31 and 33?

One Check the connection (and o-ring) between the leaking valve and the balancing chamber.

Both See AIR- 1.0.2.

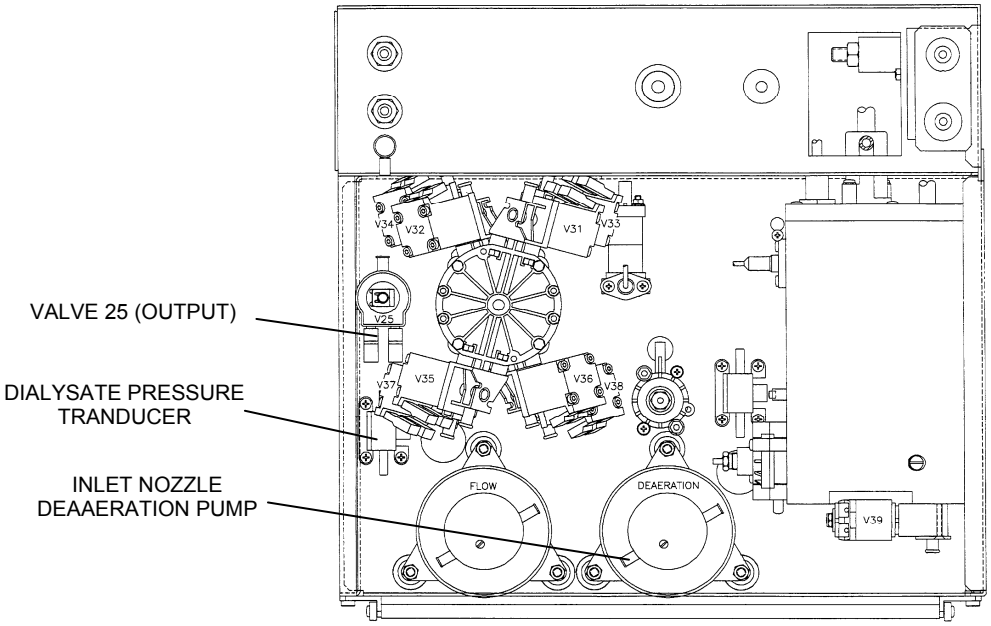


Figure 42 – Hydraulics (Rear View)

AIR- 1.0.2 CHECK BICARB INLET SYSTEM

a) Check the clear inlet bicarbonate line for air. If air is seen check for bad o-rings at the bicarbonate connector.

b) Plug the bicarbonate connector back into its port. After a few minutes check at balancing chamber valves 31 and 33. Is air still present?

Yes
a) Calibrate DEAERATION PRESSURE by first decreasing the DAC value until pressure is below -18 inHg and then increasing it SLOWLY until -24 inHg is obtained.
b) Perform SECTION 12 - INDUCED POSITIVE PRESSURE TESTS (page 80) to locate a possible leak (especially at balancing chamber valves 31 and 33).

No
Check the bicarbonate pump (o-rings), the injection site, and the mixing chamber #82 for an air leak.

SECTION 12 - INDUCED POSITIVE PRESSURE TESTS

These tests use positive pressure to locate a possible hydraulic leak.

NOTE: These tests must be performed from **DIALYSIS PROGRAM**.

a) At the top of the air removal chamber #69 is valve 43 and two male probes (see Figure 43 below).

b) Unplug the two-pin female connector from each probe and place them such that they cannot come into contact with each other. A FILLING PROGRAM should appear (debug screen 1, FILACT = "1"). If not the sensor board may be bad.

c) Clamp the clear tube from valve #43's output nozzle. During FILLING PROGRAM the only path to drain is through valve #43. Clamping removes this path and pressurizes the secondary hydraulic side to loading pressure (about +19 psi).

d) A flow error should appear (debug screen 0, FLOW ERROR = 1) and TMP should be greater than +200 mmHg.

e) Remove the fluid sample tube from the front of the machine (see Figure 43 below) and check for fluid leaks indicative of a bad UF pump output spring AND check valve #63.

f) Wait for FIVE minutes and then search **CAREFULLY** for external fluid leaks. Look **ESPECIALLY** in the area of air removal chamber #69, flow pump tubing (input and output) and the flow pump regulator #78.

g) If no leaks return the female connectors to the air removal chamber probes, unclamp valve #43. If referred to this step, return to the referring procedures and proceed accordingly.

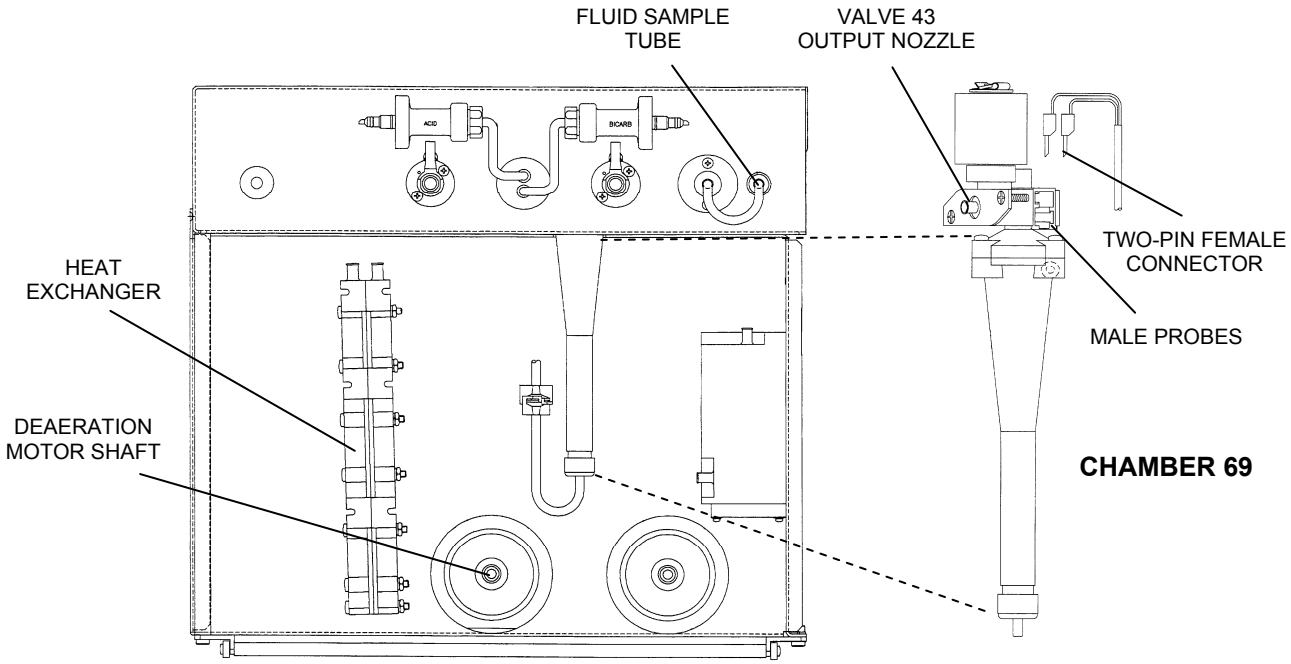


Figure 43 – Hydraulics (Front View)

SECTION 13 - DEAERATION PROBLEMS

DAIR- 1.0.0 CHECK DEAERATION SYSTEM

a) Turn flow off and call debug screen 0. Wait until DEAP = 255 and check the deaeration pump's motor shaft (see Figure 43 on previous page). If still rotating replace the actuator board (bad driver), otherwise proceed to part b.

b) Attempt DEAERATION CALIBRATION per procedure. If unsuccessful proceed to part c.

c) Clamp the solid tubing between valve #39 and the hydroblock at the location indicated in Figure 44 below. Attempt DEAERATION CALIBRATION again. Does it calibrate properly?

Yes See DAIR- 1.0.2.

No Replace the deaeration pump head and attempt DEAERATION CALIBRATION. If unsuccessful, see DAIR- 1.0.3 (the previous pump head is probably good).

DAIR- 1.0.2 CHECK ACTUATOR BOARD

a) Remove the clamp from valve #39.

b) Unplug valve 39 from the distribution board (V39, DEAR-V). Using a flashlight check, inside the distribution for corrosion (indicative of spillage).

c) If no corrosion: Is deaeration pressure good?

Yes Replace the actuator board.

No Replace valve #39.

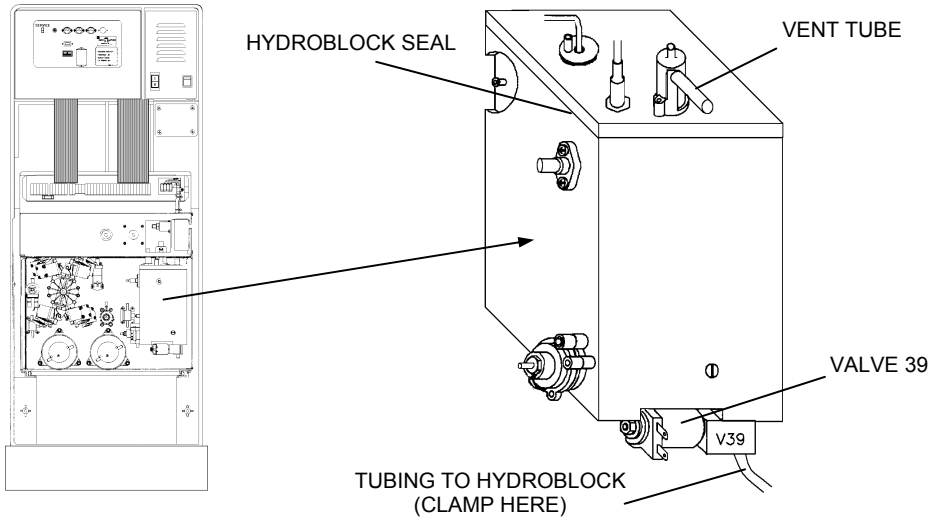


Figure 44 – Hydroblock

DAIR- 1.0.3 CHECK HYDROBLOCK

a) Turn dialysate flow off and unplug the float from the distribution board (x5, FLOAT-SW). Place a jumper wire, inside the distribution board, between **male** pins 1 and 3 (top and middle). Water should eventually flow from the vent tube (see Figure 44 on previous page).

b) While water is still flowing clamp the vent tube to pressurize the hydroblock to inlet water pressure (about 20 psi).

c) Wait one minute and look for an external leak at the top of the hydroblock (see Figure 44 on previous page). Is the hydroblock leaking?

Yes Bad hydroblock seal (part # 565642).

No Two possibilities: 1) Bad actuator board; 2) Bad deaeration pump motor or brushes (see brush replacement process in the PREVENTATIVE MAINTENANCE manual).

SECTION 14 - UF PUMP PROBLEMS

UF- 1.0.0 CHECK DEBUG UFPULS

With UF OFF (important) call up debug screen 1. Is UFPULS = "1"?

Yes See UF- 2.0.0.

No See UF- 1.0.1.

UF- 1.0.1 CHECK UF PUMP

a) Place the dialysate lines into a bucket of water.

b) Clear all blood alarms and increase the blood pump rate to full speed.

c) Select a UF RATE of 1000 ml/hr and turn UF on (IMPORTANT the green UF on/off LED MUST remain on solid).

d) Determine if the UF pump is stroking (see Figure 45 below). Is the UF pump stroking?

Yes See UF- 1.0.3.

No Turn UF off and see UF- 1.0.2.

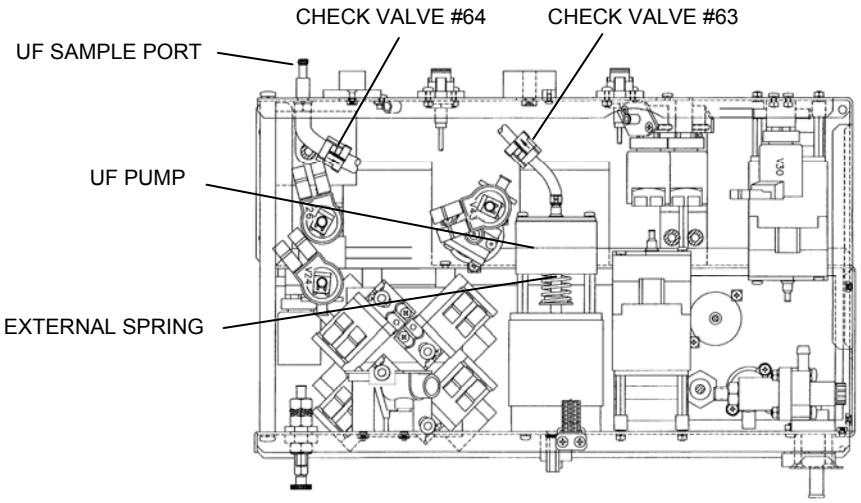


Figure 45 – Hydraulics (Top View)

UF- 1.0.2 CHECK ACTUATOR BOARD

a) Remove the cover from the UF pump's distribution board connector (P22, UF-P) and then plug the connector back in. **CAUTION** Be careful to plug in correctly!

b) Clamp meter leads between pins 1 and 5 (top and bottom, where the wires are attached).

c) Clear all alarms and turn UF on (green UF on/off LED MUST be on solid). UF rate set to 1000 ml/hr.

d) Voltage to the connector should 'pulse' from between 26 and 22 vdc to less than 2 vdc. Is this ok?

Yes Replace the UF pump.

No Two possibilities: 1) *Bad actuator board cable; 2) Bad actuator board.

* The actuator cable can be checked for continuity. Note that you are checking UF PUMP connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

UF- 1.0.3 CHECK UF OUTPUT

With UF on, remove the UF output tube from the sample port (see Figure 45 on previous page). Are there 'strong' output strokes from the tube?

Yes See UF- 1.0.4.

No a) Make sure check valve #63 is oriented properly (see Figure 45 on previous page).

b) Check the UF pump for broken springs, bad o-rings, or a bad diaphragm.

UF- 1.0.4 CHECK TMP PUMP UP

a) Turn UF off and place the dialysate lines back into the shunt.

b) Clear all blood alarms and turn UF on. Does TMP (main screen) increase to 280 or greater?

Yes Make sure check valve #64 is oriented properly (see Figure 45 on previous page).

No See UF- 1.0.5.

UF- 1.0.5 CHECK DIALYSATE PRESSURE

a) Turn UF off and tee a three-way connector into the dialysate lines with one leg going to an external pressure meter.

b) Clear all blood alarms and turn UF on. Does meter pressure increase to greater than -260 mmHg?

Yes Calibrate DIALYSATE PRESSURE per CALIBRATION PROCEDURES.

No Perform both SECTION 11 - NEGATIVE PRESSURE TESTS (page 77) and SECTION 12 - INDUCED POSITIVE PRESSURE TESTS (page 80) to locate a hydraulic leak.

UF- 2.0.0 CHECK UF PUMP SOLENOID RESISTANCE

a) Unplug the UF pump from distribution board position P22, UF-P.

b) Remove the plastic cover and measure resistance between the two soldered wires inside the female connector. Between 8 and 12 ohms?

Yes Two possibilities: 1) *Bad actuator board cable; 2) Bad actuator board.

No Replace the UF pump.

* The actuator cable can be checked for continuity. Note that you are checking UF PUMP connections and see SECTION 16 - CHECKING ACTUATOR BOARD CABLE (page 88).

SECTION 15 - BLOOD LEAK PROBLEMS

NOTE: Do not proceed unless the BYPASS LED is off (i.e. out of bypass).

BL- 1.0.0 CHECK DIMNESS

Call up debug screen 4. If DIMN is greater than 5.5 or less than 4.0 vdc check the blood leak detector's glass tube for calcium (the tube appears 'cloudy') and air bubbles. If calcium is seen run BLEACH/RINSE. If air is seen perform SECTION 11 - NEGATIVE PRESSURE TESTS (page 77) and/or SECTION 12 - INDUCED POSITIVE PRESSURE TESTS (page 80) to locate the leak.

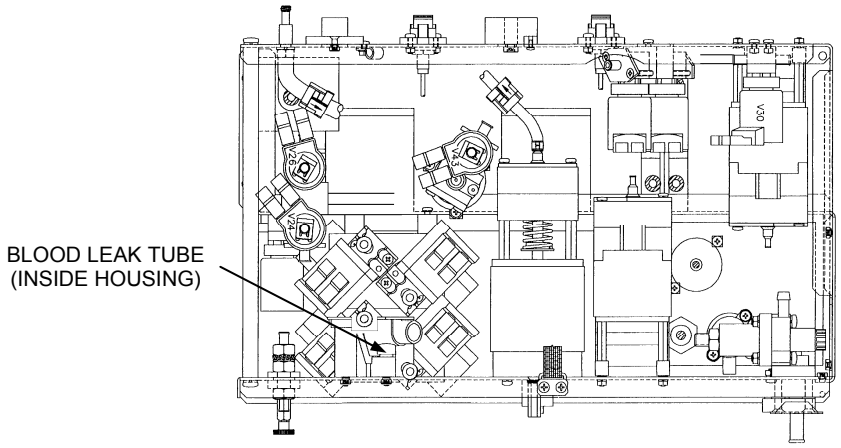


Figure 46 – Hydraulics (Top View)

BL- 2.0.0 CHECK LEAK

From debug screen 4, if LEAK is greater than 5.2 or less than 4.5 vdc attempt BLOOD LEAK calibrations per CALIBRATION PROCEDURES.

BL- 3.0.0 CHECK BLOOD LEAK SIGNALS

a) Turn the power off and place a ground lead at TEST connector SGND (see Figure 47 below).

b) Turn the power back on and return to DIALYZE mode.

d) Measure voltage, from the back (solder) side of the sensor board's, x2 connector at pin 6 (see Figure 47 below). Between 4.5 and 5.2 vdc?

Yes Currently a problem is NOT indicated. Possible intermittent blood leak detector or Sensor board.

No Three possibilities: 1) Sensor Board; 2) *Sensor board cable; 3) Bad blood leak detector.

* The sensor cable can be checked for continuity. Note that you are checking the BLOOD LEAK **OUTPUT** connection and see SECTION 17 - CHECKING SENSOR BOARD CABLE (page 90).

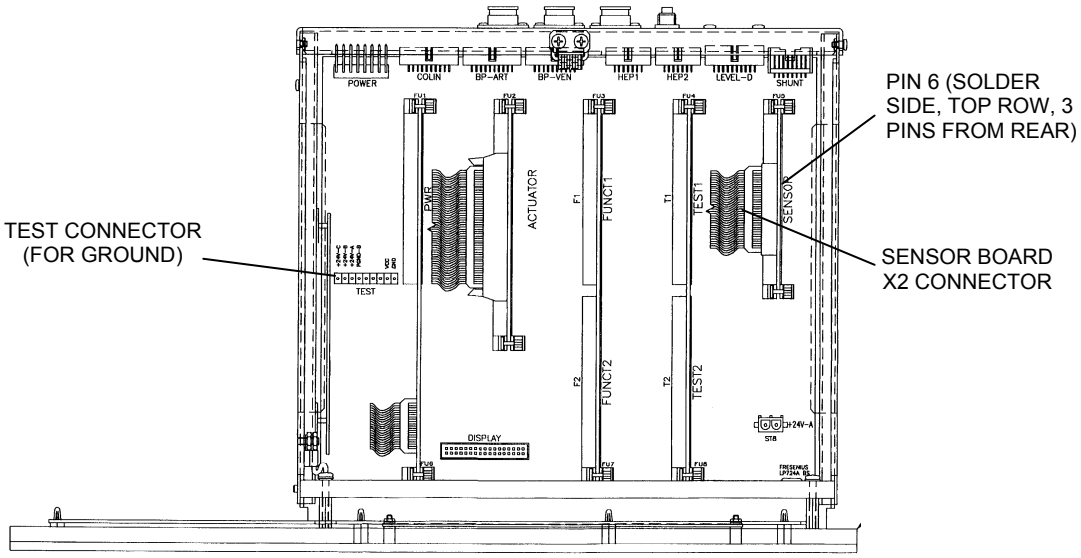


Figure 47 – Electronic Card Cage

SECTION 16 - CHECKING ACTUATOR BOARD CABLE

a) Turn the POWER OFF and unplug the actuator board cable from the distribution board (ACTUATOR CONNECTOR).

b) Using a flashlight, check inside the male connector for bent or broken pins. Check also for signs of corrosion.

c) Check the female cable end for signs of corrosion. The cable ends are arranged in two rows, even in one row, odd in the other. The TAB identifies the 'odd' row.

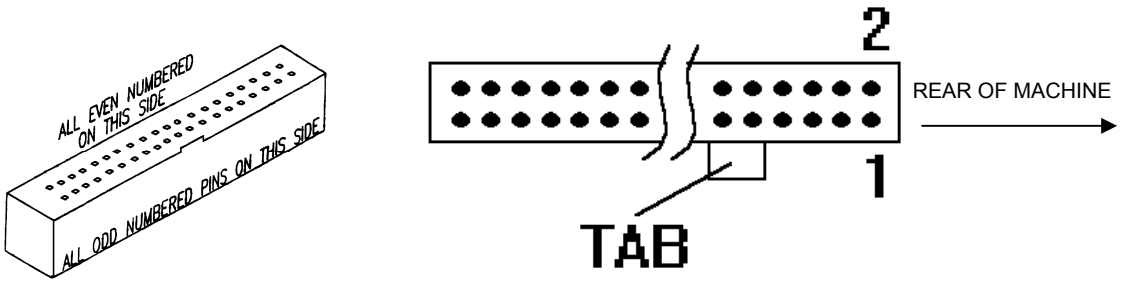


Figure 48 – Female Distribution Board Connector

d) Inside the card cage the cable terminates at connector X2 (actuator board). The solder (back) side pins of this connector are arranged in two rows. Unplug the cable from the connector and check inside the male connector for corrosion or bent pins. Reconnect the cable when check is complete.

IMPORTANT NOTE: A regular meter probe does not penetrate deep enough to make a connection. Do NOT use a paper clip or you may damage the connector.

e) Clip one meter lead to a metal object small enough to fit *loosely* into the holes of the connector. This will be used as our 'probe'. Count to the indicated female pin (see Table 11 and Table 12 on next page) and stick the 'probe' into it.

f) Place the second meter lead on the matching numbered pin (see Table 11 and Table 12 on next page) on the solder side of the connector. A good connection will measure 10Ω or less.

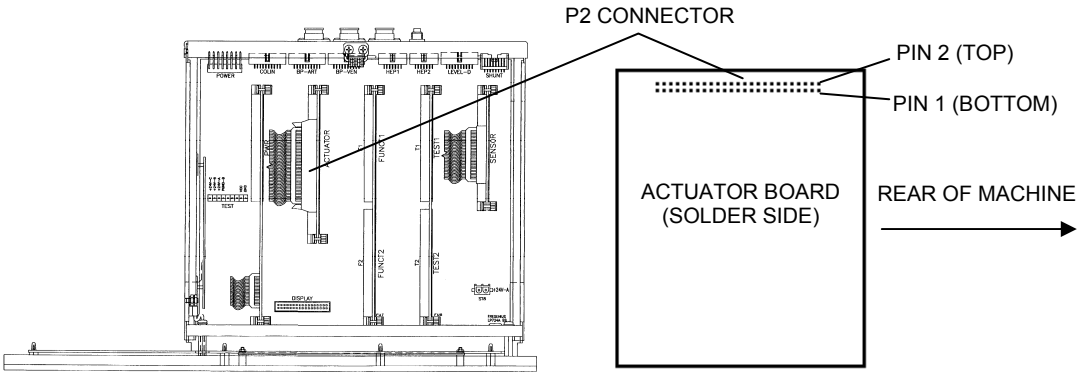


Figure 49 – Electronic Card Cage

Table 11 – Actuator Board, P2 Cable, Pin Identification (Pumps)

PUMP	P2 PIN #	P2 LOCATION
DEAERATION PUMP (1 of 2)	15	Bottom row, 8 pins from rear
DEAERATION PUMP (2 of 2)	16	Top row, 8 pins from rear
FLOW PUMP (1 of 2)	19	Bottom row, 10 pins from rear
FLOW PUMP (2 of 2)	20	Top row, 10 pins from rear
ACID PUMP (1 of 4)	1	Bottom row, first pin from rear
ACID PUMP (2 of 4)	2	Top row, first pin from rear
ACID PUMP (3 of 4)	3	Bottom row, 2 pins from rear
ACID PUMP (4 of 4)	4	Top row, 2 pins from rear
BICARB PUMP (1 of 4)	5	Bottom row, 3 pins from rear
BICARB PUMP (2 of 4)	6	Top row, 3 pins from rear
BICARB PUMP (3 of 4)	7	Bottom row, 4 pins from rear
BICARB PUMP (4 of 4)	8	Top row, 4 pins from rear
UF PUMP (1 of 4)	23	Bottom row, 12 pins from rear
UF PUMP (2 of 4)	24	Top row, 12 pins from rear
UF PUMP (3 of 4)	25	Bottom row, 13 pins from rear
UF PUMP (4 of 4)	26	Top row, 13 pins from rear

Table 12 - Actuator Board, P2 Cable, Pin Identification (Valves)

VALVE	P2 PIN#	P2 LOCATION
24	29	Bottom row, 11 pins from front
41 (27)	32	Top row, 10 pins from front
43	46	Top row, 3 pins from front
39	44	Top row, 4 pins from front
29	34	Top row, 9 pins from front

SECTION 17 - CHECKING SENSOR BOARD CABLE

a) Turn the POWER OFF and unplug the smaller sensor board cable from the distribution board (SENSORS CONNECTOR).

b) Using a flashlight, check inside the male connector for bent or broken pins. Check also for signs of corrosion.

c) Check the female cable end for signs of corrosion. The cable ends are arranged in two rows, even in one row, odd in the other. The TAB identifies the 'odd' row.

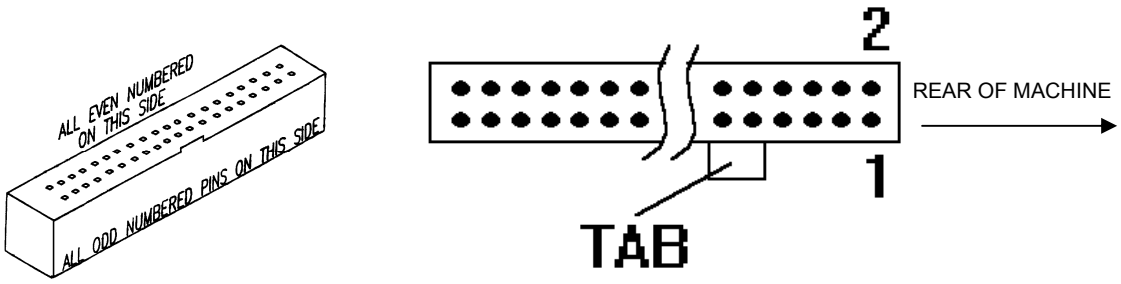


Figure 50 – Female Distribution Board Connector

d) Inside the card cage the cable terminates at connector X2 (sensor board). The solder (back) side pins of this connector are arranged in two rows. Unplug the cable from the connector and check inside the male connector for corrosion or bent pins. Reconnect the cable when check is complete.

IMPORTANT NOTE: A regular meter probe does not penetrate deep enough to make a connection. Do NOT use a paper clip or you may damage the connector.

e) Clip one meter lead to a metal object small enough to fit *loosely* into the holes of the connector. This will be used as our 'probe'. Count to the indicated female pin (see Table 13 on next page) and stick the 'probe' into it.

f) Place the second meter lead on the matching numbered pin (see Table 13 on next page) on the solder side of the connector. A good connection will measure 10 Ω or less.

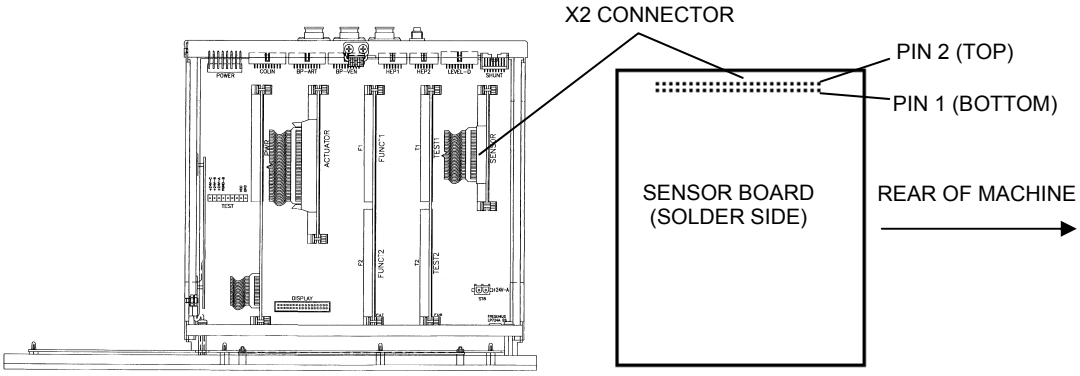


Figure 51 - Electronic Card Cage

Table 13 – Sensor Board, X2 Cable, Pin Identification

DEVICE	x2 PIN #	x2 LOCATION
NTC-3	12	Top row, 6 pins from rear
NTC-2	13	Bottom row, 7 pins from rear
FLOAT	21	Bottom row, 7 pins from front
CFS TRANSDUCER (1 of 3)	11	Bottom row, 6 pins from rear
CFS TRANSDUCER (2 of 3)	14	Top row, 7 pins from rear
CFS TRANSDUCER (3 of 3)	15	Bottom row, 8 pins from rear
COND CELL	16	Top row, 8 pins from rear
ACID EOS	25	Bottom row, 5 pins from front
BICARB EOS	23	Bottom row, 6 pins from front
AIR SENSOR	5	Bottom row, 3 pins from rear
BLOOD LEAK DETECTOR TEST	2	Top row, first pin from rear
BLOOD LEAK DETECTOR SENSOR	4	Top row, 2 pins from rear
BLOOD LEAK DETECTOR DIMNESS	3	Bottom row, 2 pins from rear
BLOOD LEAK DETECTOR OUTPUT	6	Top row, 3 pins from rear
DIALYSATE TRANSDUCER (1 of 3)	8	Top row, 4 pins from rear
DIALYSATE TRANSDUCER (2 of 3)	10	Top row, 5 pins from rear
DIALYSATE TRANSDUCER (3 of 3)	11	Bottom row, 6 pins from rear

SECTION 18 - MANUAL BALANCING CHAMBER VALVE LEAK TESTS

A. These tests should be performed if a leaking balancing chamber valve is suspected.

B. These procedures require intensive work inside the distribution board, plugging and unplugging valves and pumps.

NOTE: Reference is to the HYDRAULIC FLOW DIAGRAM

BC- 1.0.0 TESTING BOTTOM VALVES ('FRESH SIDE' PRESSURIZED)

a) Turn the machine off and clamp the clear INPUT tubing at VALVE #30 (see Figure 52 below).

b) Turn the machine on and wait for SELECT PROGRAM. Push the blue DIALYSIS screen button to see the CONFIRM CONCENTRATE message. Do NOT enter DIALYSIS program.

c) When the CONFIRM CONCENTRATE message is up the top balancing chamber valves (V31 – V34) are open; the bottom valves (V35- V38) are closed. The deaeration pump runs continuously, which pressurizes 'fresh side' valves #35 and #37. Enter debug and confirm this from screen 0.

d) Call screen 4. PDIA should be approximately 5 volts. Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA steadily decreasing?

Yes A leak at valve #35 or #37. See BC- 1.0.1.

No See BC- 2.0.0.

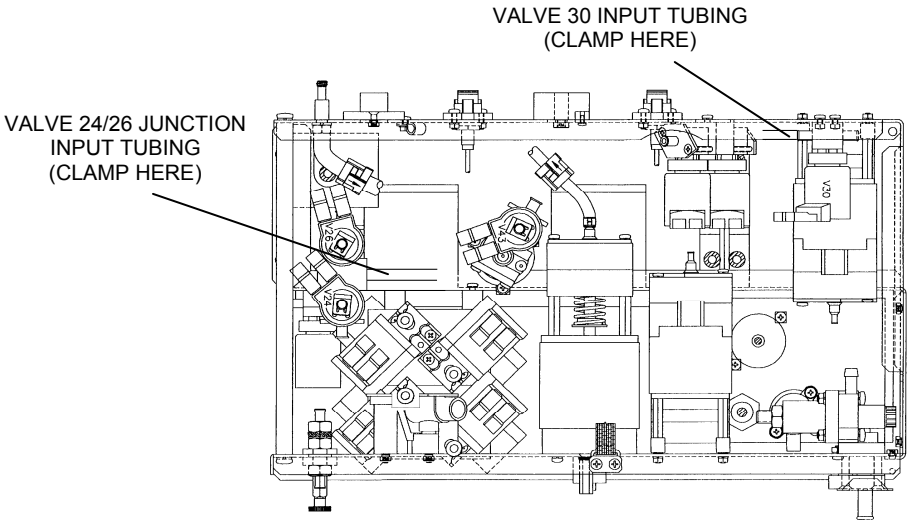


Figure 52 – Hydraulics (Top View)

BC- 1.0.1 LOCATING THE LEAK

a) Clamp the clear tubing at balancing chamber valve #32 (see Figure 53 below), turn the power off and back on.

b) From the SELECT PROGRAM screen push the blue DIALYSIS screen button to see the CONFIRM CONCENTRATE message. Do NOT push the CONFIRM key to enter DIALYSIS program.

c) Call debug screen 4 and monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA decreasing STEADILY**?**

Yes Valve #37 is leaking (see Figure 53 below)

No Valve #35 is leaking (see Figure 53 below)

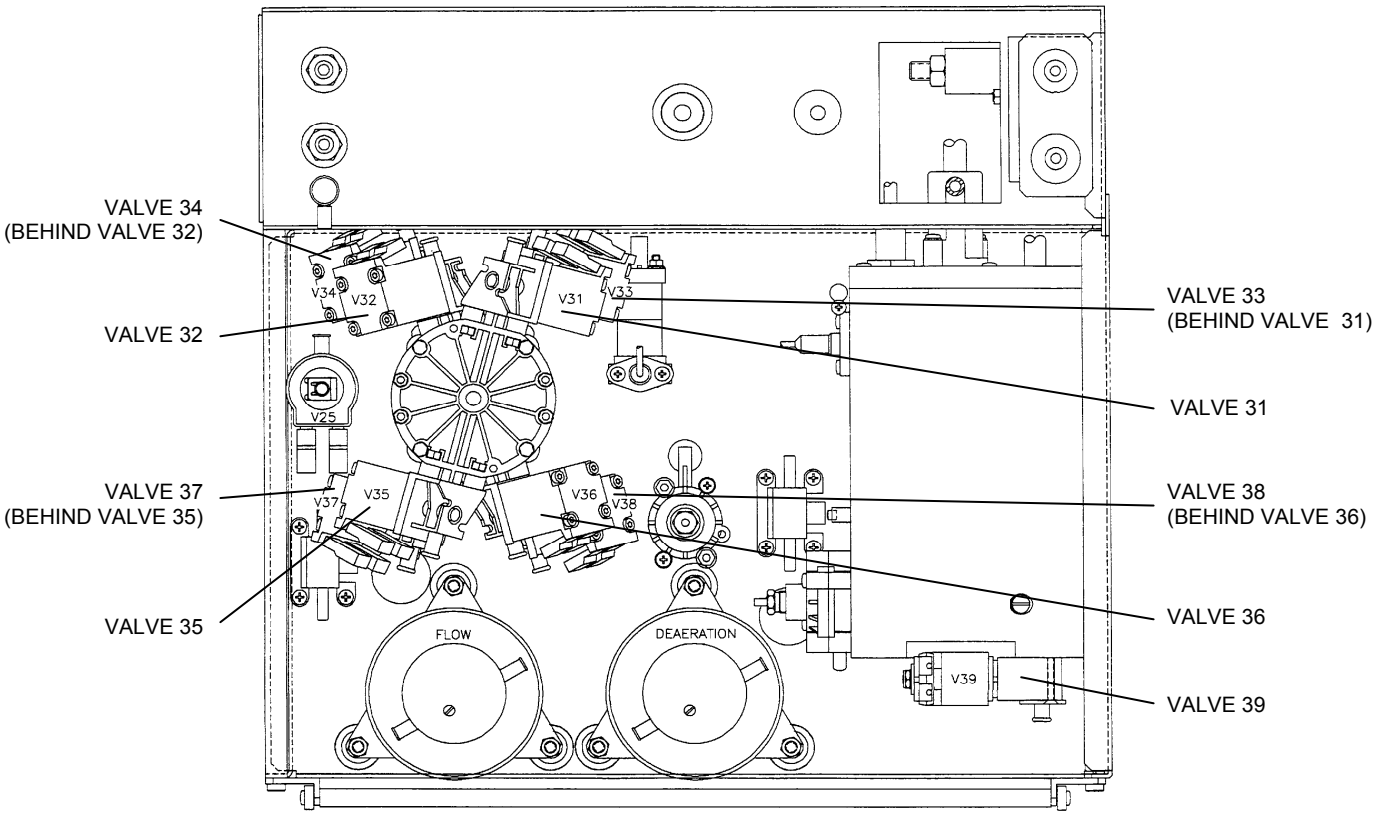


Figure 53 – Hydraulics (Rear View)

BC- 2.0.0 TESTING BOTTOM VALVES ('SPENT SIDE' PRESSURIZED)

a) Remove the clamp from valve #30 and clamp the clear INPUT tubing at the valve 24/26 JUNCTION BLOCK (see Figure 52 on page 92).

b) Turn the heater breaker switch (back panel) off (see Figure 6, page 5).

c) Plug the flow pump's distribution board connector (P21, FLOW-P) into the deaeration pump's position (P20, DEGAS-P), leaving the deaeration pump unplugged. The flow pump is pressurizing against 'spent side' valves #36 and #38.

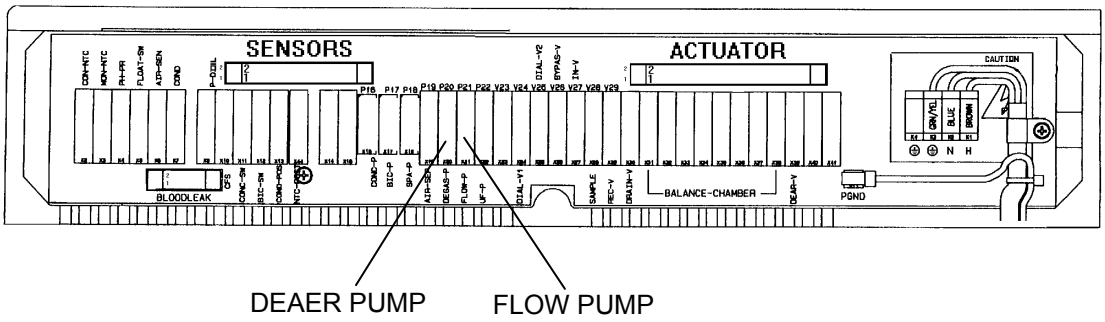


Figure 54 – Distribution Board

d) Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA steadily increasing?

Yes A leak at valves #36 or #38. See BC- 2.0.1

No See BC- 3.0.0

BC- 2.0.1 LOCATING THE LEAK

a) Clamp the clear tubing at valve #32 (see Figure 53 on page 93) as close to the valve as possible. Turn the power off and back on.

b) From the SELECT PROGRAM screen push the blue DIALYSIS screen button to see the CONFIRM CONCENTRATE message. Do NOT push the CONFIRM key to enter DIALYSIS program.

c) From CONFIRM CONCENTRATE call debug screen 4 and monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA STEADILY increasing?

Yes Valve #38 is leaking (see Figure 53 on page 93).

No Valve #36 is leaking (see Figure 53 on page 93).

BC- 3.0.0 TESTING VALVE #32 ('SPENT SIDE' PRESSURIZED)

a) Plug valve #36 into #32's distribution board position and visa versa.

b) Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA STEADILY increasing?

Yes Valve #32 is leaking (see Figure 53 on page 93)

No Plug the valves back in correctly and see BC- 3.0.1.

BC- 3.0.1 TESTING VALVE #34 ('SPENT SIDE' PRESSURIZED)

a) Plug valve #38 into #34's distribution board position and visa-versa.

b) Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA STEADILY increasing?

Yes Valve #34 is leaking (see Figure 53 on page 93)

No Plug the valves back in correctly and see BC- 4.0.0.

BC- 4.0.0 TESTING VALVE #31 ('FRESH SIDE' PRESSURIZED)

a) Remove the clamp from the valve 24/26 junction block and clamp at valve #30's INPUT again.

b) Plug the pumps back into their proper positions (P20, DEGAS-P) (P-21, FLOW-P). The deaeration pump is now pressurizing against 'fresh side' valves #35 and #37.

c) Plug valve #35 into #31's distribution board position, and visa-versa.

d) Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA STEADILY decreasing?

Yes Valve #31 is leaking (see Figure 53 on page 93)

No Plug the valves back in correctly and see BC- 4.0.1.

BC- 4.0.1 TESTING VALVE #33 ('FRESH SIDE' PRESSURIZED)

a) Plug valve #37 into #33's distribution board position and visa-versa.

b) Monitor PDIA for two minutes. Ignoring small up and down fluctuations, is PDIA STEADILY decreasing?

Yes Valve #33 is leaking (see Figure 53 on page 93)

No Plug the valves in correctly. A leak is not indicated using this test.

SECTION 19 - TESTING FOR A LEAKING BALANCING CHAMBER DIAPHRAGM

This test uses BALANCING CHAMBER VOLUME CALIBRATIONS in an attempt to locate a leaking balancing chamber (BC) diaphragm. There are two parts, collecting volumes from the fresh and spent sides of the diaphragm. For accurate measurements use a dry 100 ml graduated cylinder for each part.

PART I CHECKING THE FRESH SIDE

a) Loosen the drain hose from the drain port at the back of the machine (don't remove it yet). Do NOT take measurements from the end of the drain line!

b) Place the machine into service mode and push the blue CALIBRATE HYDRAULICS screen button.

c) Push the blue BALANCE CHAMBER screen button. The screen displays: CALIBRATE BALANCE CHAMBER.

d) Push the (blinking) Prime key and allow 30 seconds. Push the Prime key again to stop it.

e) Push the CONFIRM key. The screen displays: PREPARING BALANCE CHAMBER followed by: PREPARING TO CALIBRATE.

f) You have 20 seconds to remove the drain hose and prepare to collect fluid output, from the port, into the cylinder. Two cycles will be dispensed. If spillage occurs start over! **Do NOT change the screen volume.** Collected volume should equal the volume on the screen. Any discrepancy (to the high side) may indicate a leaking BC diaphragm.

g) Push the blue CALIBRATE HYDRAULICS screen button and then the ESCAPE key.

Theory: The deaeration pump loads the balancing chamber with fresh dialysate, at high pressure, displacing spent to the drain. High pressure on the fresh side of the diaphragm may result in higher volumes to the drain if the BC diaphragm is torn.

PART II CHECKING THE SPENT SIDE

a) Reconnect the drain line.

b) Repeat the above procedure until "PREPARING TO CALIBRATE" appears.

c) You have 20 seconds to remove red and blue quick connectors from the shunt, put the red quick connector into a bucket of water and prepare to collect the two-cycle output, from blue quick connector, into the cylinder. If spillage occurs start over! **Do NOT change the screen volume.** Collected volume should equal the value on the screen. Any discrepancy (to the high side) may indicate a leaking BC diaphragm.

Theory: The flow pump fills the balancing chamber with spent dialysate displacing fresh into the blue dialysate line. The higher pressure on the spent side of the diaphragm may result in higher volumes into the blue dialysate line if the BC diaphragm is torn.

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COMMON CONVERSIONS

PRESSURE

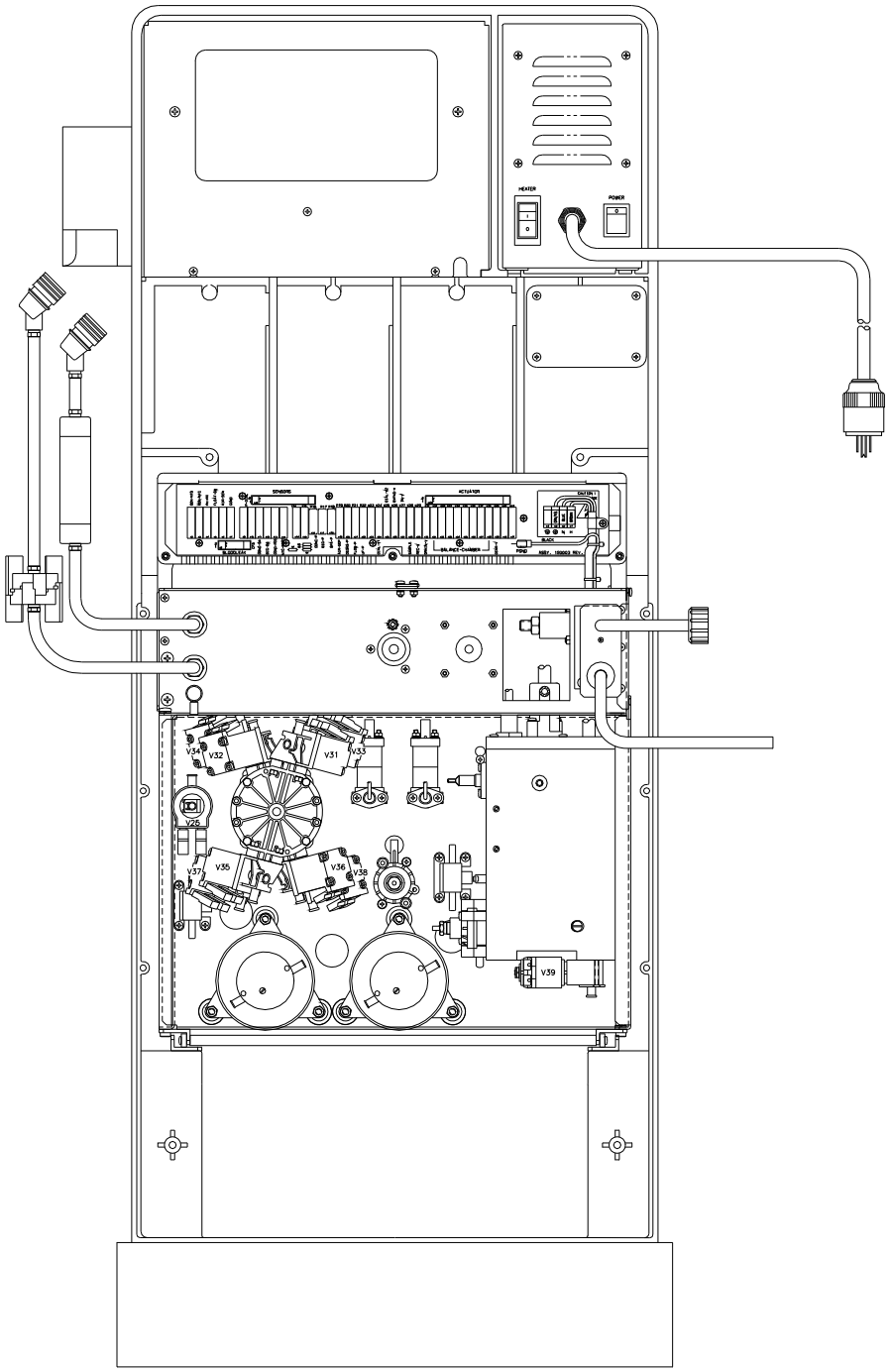
1 Bar	29.53 inHg
1 inHg	25.4 mmHg
1 Psi	51.72 mmHg

VOLUME

1 FLUID OUNCE	26.6 MILLILITERS
1 U.S QUART	0.946 LITERS
1 U.S. GALLON	3.8 LITERS
0.034 FLUID OUNCES	1 MILLILITER
1.057 QUARTS	1 LITER
0.26 U.S. GALLON	1 LITER

MASS

1 OUNCE (avdp.)	28.35 GRAMS
1 POUND (avdp.)	0.45 KILOGRAM
0.035 OUNCE (avdp.)	1 GRAM



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